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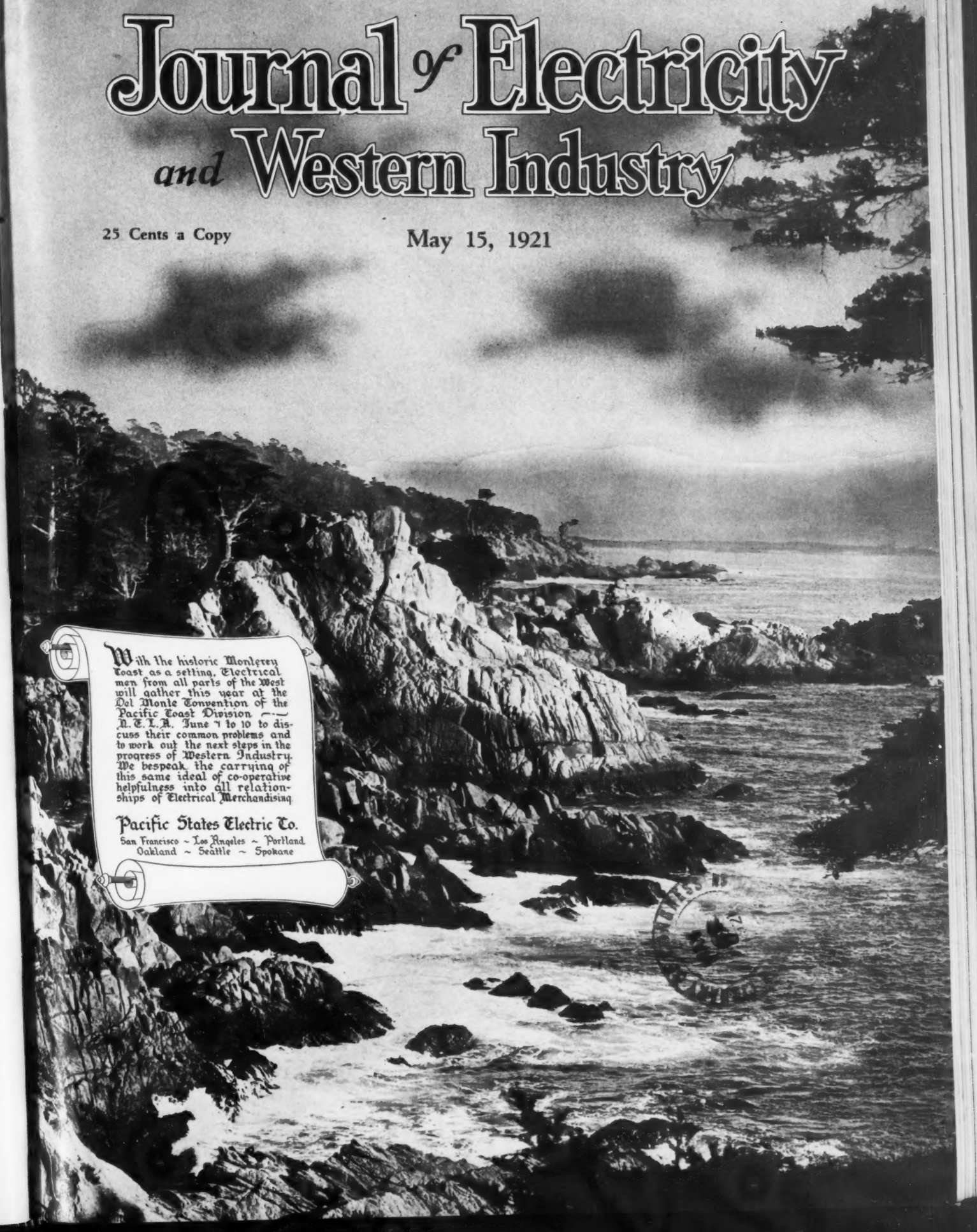

With the historic Monterey Coast as a setting, Electrical men from all parts of the West will gather this year at the Del Monte Convention of the Pacific Coast Division N. E. L. A. June 7 to 10 to discuss their common problems and to work out the next steps in the progress of Western Industry. We bespeak the carrying of this same ideal of co-operative helpfulness into all relationships of Electrical Merchandising

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Unsurpassed Vision Backed by the Most Painstaking Research

HERE is shown one of the great flashover tests that have been performed by Professor Harris J. Ryan of Stanford University, in cooperation with the electrical engineers of the West and the Pacific Coast Division, N. E. L. A., in establishing with painstaking accuracy through experimental research the fact that 220,000 volts may be profitably and economically transmitted over vast distances in the West.

The conditions of experiment in the picture here reproduced were the same as those given for Fig. 4 on page 478, except that the upper 8 units in each string were shorted, making a 7-unit "V" string of 5¾ inch spacing. 10-inch discs; 30 flash-overs.

Clearances	Path Length	No. of Discharges*
Right outside ring to insulator top	36″	11
Right inside ball " " "	35″	25
Left " " " " "	38″	18
Left outside ring " " "	35″	30
Center ball to cross-arm	58″	26
		110

*While but 30 discharges (wave trains) were heavy, all parted, each taking successively several different routes.

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Journal of Electricity and Western Industry

A publication devoted to the upbuilding of the great industrial West and the countries bordering on the Pacific

A McGraw-Hill Publication

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Interpreting Western progress through the application of electric power, light, and heat in industry and in the home

Vol. 46, No. 10 SAN FRANCISCO, MAY 15, 1921 Per Copy, 25 Cents

HERE IS THE ARGUMENT—DOWN IT

FROM the people themselves, due to a thoroughly awakened public consciousness, there is going out through every channel of industrial and commercial life in the West a plea that fair play be accorded the public utilities and the public service industry. Our great West needs vast sums of money and needs them badly. The unlocking and the developing of our water resources must go on. It has often been pointed out that unless the public can appreciate more sympathetically the situation of the public service industry, these vast sums of money cannot be obtained. Frequently the public has turned an indifferent ear to this tale, stating that the situation is exaggerated, that ample funds are available, and that investors are not being turned away from this field to other more lucrative opportunities. On page 534 of this issue will be found a letter written by a prominent banking house, in an endeavor to compete with public utility securities; and behold the message there being put over to the prospective investor! In this instance there is involved a sum of $12,000 and the question has arisen as to whether California utilities shall receive this money for investment. See the argument that is being offered. Surely, the people of the West can no longer stand in the background and tolerate anything which may jeopardize the standing of the utility securities—the keystone of the arch in the upbuilding of the West. Such investment houses as the one cited should be given full publicity in the event of the repetition of this offense, in order that the people of the West may know who it is that would tear down their credit, weaken the progress of development, and suspend the great hydroelectric program now under way in the West.

A Year of Magnificent Achievement

A year ago at the Pasadena Convention of the National Electric Light Association, the West promised the undertaking of a gigantic program in hydroelectric power development. The year that has just passed has made good this promise in every respect. Not only is the program of $750,000,000 expenditure for the next ten years well under way,—something like $110,000,000 having gone into new development work during the past year,—but the increased efficiencies in operation for both steam and electric work combined with commercial and engineering achievement bid fair to make this year of 1921 the banner year in accomplishment.

In commercial sales work very distinct advances have been made. The California Electrical Cooperative Campaign, in furthering the Electrical Home idea, designed fundamentally to emphasize the installation of the convenience outlet in the modern home, has given to the nation a new conception of how the method electrical can be gotten over to the people directly. During the past year, five of these homes have been completed and equipped in different cities of California, and been visited by something like 150,000 people. Close upon the heels of the electrical home has followed the question of educating the public in the better use of industrial and commercial illumination. This has been accomplished by means of effective exhibits located at San Francisco and Los Angeles, combined with a traveling exhibit sent through the smaller cities of the state to teach contractor-dealers and industrial men the "how" and the "why" of better commercial and industrial illumination. Its effects are already visible in the closer attention that is being paid to this subject in recent installations in industry, the office, and in the house, as well as in the overhauling of inferior equipment already installed.

Coming now to the question of engineering accomplishment during the past year, the successful effort to overcome a threatening power shortage covering several months, brought about in the operation of both steam and hydro-electric plants, efficiencies that were thought impossible. The methods which have been evolved may be found worked out in considerable detail elsewhere in this issue. But in the field of actual installation the new records that have been made in the past year surpass all the other brilliant achievements of that period. The increase in size of transformer units, which now have 220,000 volts as their limit, together with the development of generators of vastly increased capacity, give evidence of the thought of the manufacturer in helping to meet the insistent demand for more and greater blocks of power. Then, too, there is the development of distance of transmission and the height of voltage which has recently culminated in a new record in

high tension transmission in the Caribou plant of the Great Western Power Company, operating at a voltage of 165,000. Following close upon this great accomplishment is the new ideal of 220,000-volt installation, now well under way in the announced plans of two great companies in the West.

The outlook for the storage of waters and the vision of possible hydroelectric generation has widened. Thus we find the Southern California Edison Company, for instance, setting as a new target to shoot at, the great Colorado River development of two and a half million horsepower, requiring a dam 500 ft. in height, the storage of 25,000,000 acre-ft. of water, the creation of a lake 200 miles in length, and the ultimate transmission of hydroelectric energy over greater and longer distances, which will necessitate voltages higher than any hitherto dreamed of as possible.

But of all the accomplishments to be recorded, the one that gives the West more hope and encouragement than any other is the increasingly better understanding between the public service industry and the people themselves. So much better has this understanding become that we find during the past year the radical element in the California Legislature, after an exhaustive hearing before the people throughout this commonwealth, entirely won over to the real issue involved in the hydroelectric program, namely, that the fact that the well being of the people of the commonwealth is inseparably bound up with the steady progress of the public service industry.

The final outcome of it all is that today utility securities, of the West particularly, have advanced step by step until they have now passed industrials and are well up in the top reaches of the market, insofar as security sales and valuations are concerned. In view of all these accomplishments, then, it may well be said that the spring of 1921 marks the completion of a year of magnificent achievement in the West.

Enter the Electric Range

Thoughtful men throughout the West are giving unusual attention to the question of forecasting the next new industrial move ahead. While it is difficult to attempt a complete analysis at this time, certain features of early development stand out in bold relief. There is no question but what the building situation, particularly that of the housing problem, is a pressing one, and must find relief. That the type of architecture which will arise as a result of the present stress will be very different from that prevailing in the past, no one questions. The buildings of the future, so far as the residences are concerned, will be smaller in size, more compact in arrangement, but equipped with every modern labor-saving device that the genius of man has contrived.

With the growing price of fuel oil, the scarcity of any other type of fuel in the West, and particularly the increasing development of hydroelectric energy, the problem of electric cooking and the consequent entrance of the electric range as a powerful factor in the economic side of home life in the West, seems to be established beyond the question of a doubt. Today the power companies that serve Salt Lake City, Spokane and certain districts of Southern California boast of their three to four thousand electric ranges, and en masse these ranges constitute perhaps the greatest number installed in the United States today. Close observers feel that the problem of the future will not be that of the isolated range installation, but rather whole districts that may be modernized in this process of electrifying the home and lightening the labor of the housewife.

There is some question as to whether or not the merchandising problem of the electric range in the future must be thoroughly overhauled. Complete districts perhaps may be handled on some cooperative plan of merchandising. At any rate, the electric range has established an economic reason for its existence, and it is up to the power companies to determine how regulation in power distribution may be obtained best under electric range loads far greater than those which have prevailed in the past; and it is up to the distributing agencies to work out a scheme of distribution that will prove profitable to themselves, and above all economical and efficient for the consumer. For the range has come to stay, and its uses in the future will be so far in the lead of its installations in the past that practically no precedent will be found wherewith to measure it.

The follow-up of service is vital to the successful operation of the electric range. It would seem that the central station cannot afford to pass control of wiring and installation on to other hands, unless a united industry underwrites the distribution problem of merchandising, wiring, installation, operation and service in such a way that the consumer gets absolutely the best and most economical standardized service obtainable.

Long Range Weather Forecasting

To the average citizen, weather forecasting is one of the occult sciences which is classified with crystal gazing, necromancy and fortune telling — you have two guesses and according to the law of averages you will probably be right fifty per cent of the time. To the engineer, however, weather forecasting has recently taken on new interest, for he is attempting to find out some way to determine scientifically what kind of a winter we are going to have next year, and the year after next. If this information could be determined with some degree of accuracy it would be of inestimable value not only to the power company engineer in the operating department, who is interested in determining how much water to leave in his storage reservoirs, but also to the construction engineer who wants to know how long he can work on a certain job before the snow runs him out. Its greatest value, however, would be to the farmer who at the present time has to depend on the patent medicine almanac to find out when to plow, harrow and plant.

At one of the meetings of the engineering com-

mittee of the N. E. L. A. some of the most noted meteorologists of the country were invited to attend a special session devoted to the discussion of long range weather forecasting, and many different ideas were put forward. A resumé of three of these papers is given in this issue of Journal of Electricity and Western Industry, and while the subject is one of primary interest to meteorologists, it is hoped that engineers will interest themselves in this problem, the solution of which would be of value not only to themselves but also to industry. The engineering committee is to be congratulated upon bringing this matter to the attention of the electrical industry, and should continue to carry on the investigations regarding this important subject. With the wealth of the West dependent upon the development of its hydroelectric resources it is of the greatest importance that we have accurate knowledge of all the factors that enter into the most economical utilization of those resources. If by successful long range weather forecasting we should be able to increase the output of our various hydroelectric plants, then it is as important that some study be given that subject as that the efficiency of prime movers and generators be increased.

The Training of Salespeople

One of the important problems that face the contractor-dealer today is that of training his salespeople so that they will be on a par with the salespeople of the other merchandising establishments. While the clerk in the hardware store or the dry goods store has the benefit of the experience of salesmen in these lines for hundreds of years, the art of selling electrical merchandise is still in its infancy, and there is much to be worked out. There are of course many good selling points used by clerks in general which apply to the sale of merchandise of no matter what description, but active research is needed to determine the best methods of selling the strictly electrical line of appliances.

In times past the customer going to a dry goods store would ask for underwear without specifying any special brand, but due to national advertising the customer now asks for and demands "B.V.D.'s" or some other brand, the high quality of which has been impressed upon him by the advertisements he has seen in magazines. The same is true of electrical merchandising, for where customers used to ask for a washing machine, now they have some special make, with the mechanical features of which they have been impressed, either by looking at their neighbor's or through the advertisements they have read. The customer who is brought into an electrical merchandising establishment by advertising of one sort or another, or by a window display, is already half sold on some particular appliance, but it remains for the electrical merchant of today to study his clerks and customers so that the customer may not only be sold completely, but will also be half-way or completely sold on several other appliances before she is ready to leave the store. The day of the merchant who deals exclusively in electrical merchandise is at hand. Let the West make the rapid strides in this profession that it has made in all the other branches of the electrical industry and solve this problem.

Industrial Heating by Electricity

The advances during the past year in industrial and commercial heating by electricity have been great, and have covered a wide field. The report on this subject made by the Industrial Heating Committee of the Commercial Committee to the Pacific Coast Geographic Division of the National Electric Light Association is printed in this issue of Journal of Electricity and Western Industry. The principal advantages of using electricity in bake ovens and enameling ovens in low-temperature industrial heating, and in brass and steel furnaces in high-temperature industrial heating, are cleanliness, absence of products of combustion, ease of operation and efficiency. These advantages offset comparatively high rates charged for this class of service. The list of industries that find it economical to use electric heating in spite of these rates is continually growing.

In the past the power companies' loads have been growing so rapidly with the lighting and motor loads that they have had but little time to devote to the development of a load which would fill the valleys in the load curve. Most of the electric heating installations can be operated during off peak hours, and would be, if a suitable rate were offered. This class of service should be developed by the electrical industry as it is a good source of revenue for all branches of the industry, and is a service to the public which would be beneficial not only in spreading the electrical idea but also in bringing into service new forms of electrical heating apparatus.

The N. E. L. A. Service Bureau

A report has just been issued on the activities of the N. E. L. A. Service Bureau for the past year. It is a most convincing document in proof of the need and the value of just such an organization. During the past year this bureau answered over one thousand requests for information from power companies and others, most of them requiring extensive research work and compilation of data. Aside from this routine work, the bureau has been of the utmost service in supplementing the work of other departments in N. E. L. A. work, among other undertakings assisting the Water Power Committee in their work with the Federal Power Commission in the formulation of rules and regulations for the administration of the Federal Water Power Act. Those members of the N. E. L. A. who are not familiar with the rate book or the department of rate research should know what facilities are open to them. One power company is on record as having appealed for assistance to this bureau sixteen times during the year. They have learned how to use their resources. Have you?

Now Is the Time to Cooperate

It is easy to be generous when you are prosperous—and it is a simple matter to live up to the ideals of cooperation when you have all that you want anyhow and would just as soon let the other fellow have what is left over. The present is not an era of left-overs, however; times have changed from the almost careless prosperity of a rising market to what is perhaps a more normal situation—at any rate, one which has placed the merchant again on the defensive, pursuing rather than accepting business.

It is a natural thing that the various cooperative movements which have been carrying this doctrine to all parts of the West should discover with harder times that they had not gotten quite as far in educating their public in the ways of righteousness as they had hoped they had. There will be backslidings in various districts and the old order of suspicion and destructive competition will show its head here and there. But there is no reason to be discouraged—only an incentive to more vigorous work.

The test of cooperation is right here. It is a good thing—we have proved it and we have practiced it when it was easy. It has never been preached on the merits of its virtue alone, but also and more particularly because its virtues were guaranteed ultimately to bring the greatest return in dollars and cents—because, in other words it represented the course of enlightened self-interest. The argument still holds—and dollars and cents have an even more powerful appeal today than they had some years ago. Now is the time to cooperate.

Indeterminate Sentence and Industry

Industry of the West is vitally involved in the promotion of the welfare of its citizens. Warden Johnston of San Quentin, one of the California state penitentiaries, recently addressed in a most eloquent and fitting manner members of the Commonwealth Club of San Francisco on the indeterminate sentence and its operation in the state of California. He showed quite conclusively that the indeterminate sentence, far from lessening the sentences of men had in cases where the sentence was insufficient greatly prolonged the sentence. Repeaters of crime generally offend against property, seldom against persons. Industry then, becomes vitally affected by the subject of the indeterminate franchise. Protection to industry is better accomplished by correction. Anything that will displace ignorance with intelligence, and despair with hope, is for the betterment of industry, and we commend Warden Johnston for his sincerity of action, and the magnificent work that he is accomplishing in the state of California in his protective measures for industry by the corrective process of the indeterminate sentence.

An awakened public consciousness looking toward salvaging the wreckage of humanity, adds two for every one so replaced—for it lessens the ranks of the idle and hopeless on the one hand, and on the other hand adds to the upbuilders of useful citizenry.

Exorbitant Commissions For Promotion

In order that industry may thrive throughout the West, legitimate enterprises should receive financial support without the drain of exorbitant commission rates for service rendered. The Commissioner of Corporations in the state of California, for instance, has instituted a 20% fee for such service. There are well authenticated instances of legitimate industrial enterprises being financed in the West, where financiers are holding up the men involved in this work to the extent of 33%. This kind of thing will be frowned upon by all well-wishers of industry in the West, and such instances as these should, if the practice does not cease, be given full publicity in order that the West may know who these men are. Some of them, perhaps, we have thought to be leaders in the promotion of industry, rather than sharks out to prey upon legitimate industrial growth in an empire in the making. This is but another chapter in the story of cooperation—a chapter which ushers in a new day of better business relationships.

The Passing of the Business Secret

The tendency of the present era is toward cooperation, primarily for the reason that cooperation pays. Incidentally, of course, it has brought a new ethical element into business—the logical connection between the two phases being left as a matter for religious discussion. One form of cooperation is the sharing of ideas and of so-called "business secrets" in efficient methods and successful policies. The old formula of business was "Tell nothing and learn all you can"; the new one seems to be that if you have a good idea, it is worth while to pass it on to your competitor and thus help to raise the level of the whole group. This new vision is by no means universal, but so thoroughly has it been accepted by some of the more progressive companies in electrical and industrial fields that it seems almost as though they kept no secrets of process or policy, but welcomed inspection of every detail. And again without arguing the logical connection, it is an easily established fact that it seems always to be the most successful concerns which hold this policy.

One large copper company of the West is an example of this type of cooperation. It pays, according to the officials of this concern, who state that they have already gained more from suggestions gleaned from others than anyone could possibly obtain from them. A similar spirit is to be observed in certain notable electrical manufacturers, wholesalers, dealers and power companies in this district—and wherever the full light of publicity is welcomed, you will find as a rule that that company is more progressive and more successful than its fellows—better liked by competitors and customers as well.

If you are ashamed of your methods, by all means conceal them—but in that case only until you can make them better. If you have something worth being proud of, experience has shown that it will be no loss to yourself to share it with your neighbors.

220,000-Volt Transmission Progress

BY JOHN A. KOONTZ

(The great distances which must be traversed by western transmission lines make the smaller wire required for high voltages a very important economy. Laboratory research such as that described in the Engineering Sub-Committee's report to the Pacific Coast Division, N. E. L. A., has been a primary factor in making possible the high tension transmission which is so vital to the development of the West.—The Editor.)

The problem of 220,000-volt transmission has been one of the goals of the electrical engineer for a number of years. At first it seemed to be the fancy of a dreamer, and few indeed realized how soon it would become a necessity. It is still difficult to realize that the many obstacles, both of an engineering and financial character, can be met, and that the time has arrived when it becomes an economic necessity that such a high voltage must be used, on account of the rapid growth of the power demand.

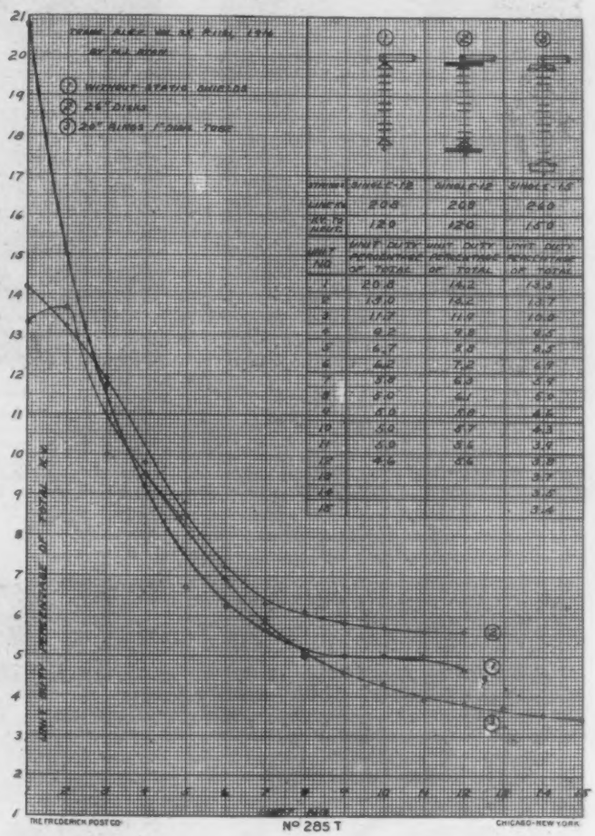
The transmission engineer, the public service executives and the financiers have each had their problems to solve to keep abreast of the demands made on their systems. In numerous cases where the executives did not have exceptional vision and confidence in the future of their business, they have failed to keep ahead of the ever-increasing power demand. The public, however, should not criticize, but stop and consider that during a period of a little over thirty years, the central stations have grown from their infancy into one of the most important industries of our country, and one that is going to grow to be of more importance in the development of other industries, and of the nation, as the years go by, and the fuel situation becomes more acute.

With the central station growth, and the utilization of water power and coal at their sources, it is only natural that transmission facilities must be increased, and they have been increasing at a rapid rate, till today we are planning on building transmission lines of 250 miles in length which have 125,000-kw. capacity.

The last of the engineering problems to be solved were those of Corona, Regulation and Insulation. Due to the extensive work of Mr. Peek and the early work of Mershon and Professors Ryan and Whitehead, we have only refinements to gain in the future studies of Corona, there still being some doubt as to the effect of certain surface conditions on large size conductors, ¾-inch diameter and larger, caused by rope stranding or the use of special strand combinations to increase the effective diameter. Some experimental work should be done along this line. It would also be instructive to have the Corona loss measurements made on a new high voltage line, and the test repeated under similar conditions after several years of service, to note if there is any material increase due to the conductors weathering, or whether the loss actually decreased due to the Corona removing rough projections that might occur on the new wire.

For a number of years Voltage Regulation seemed to be a serious problem on long high voltage lines, and it appeared that both the length of lines and the maximum voltage at which they could be operated, together with the grade of service rendered, might be limited by voltage regulation, but this is no longer the case, for by use of ample synchronous condenser capacity, the 220-kv. line of tomorrow will give less voltage fluctuation than did the 60-kv. line of one-fourth the length as constructed ten years ago. Were it not for the synchronous condenser, operated by automatic regulators, correcting the power factor and by so doing lessening the line loss, the high voltage lines of today, and the higher voltage lines of the near future, would not be possible. High voltage lines can only be made to give satisfactory service by proper phase control of the current, and either relieving the lines of the lagging wattless load components under maximum load conditions, or supplying such a component to the line under light load conditions, to prevent voltage drop or rise as the load conditions demand. This can now be accomplished by the use of standard commercial apparatus, and the terminal voltage held constant from no load to full load.

It must not be lost sight of that with high voltage transmission lines, both generators and synchronous condensers must be of such capacity and so designed that the generators will take care of the line charging current without excessive voltage, and the condensers of ample capacity to neutralize the wattless lagging load current, and designed to furnish sufficient wattless lagging current to the line under no load conditions to prevent appreciable voltage rise.



To make each disc in a string of insulators carry its share of the strain for high voltage transmission has been the subject of deep research in the West. Here is a series of experimental curves established by Professor Harris J. Ryan of Stanford University, that show conclusively the helpfulness of static shields in solving the problem.

Insulation

Because of the extensive studies that have been made during the year, the proposed 220-kv. lines will in all probability be insulated better relatively than existing 110-kv. lines. Insulation, however, has been one of the hardest problems, and one that will continue to require thorough investigation, probably extending over a period of years, and in-

volving the operating experience of a number of companies under various conditions, before the many factors involved can be fully appreciated or taken care of in the best manner.

Porcelain seems to still remain the only material suitable for making high voltage insulators, but as to the proper body mixture, the proper firing temperature and the shape or the methods of hardware attachment, there still remains a wide diversity of opinion, both among the ceramists and the engineers. However, the cap and pin type insulator is by far the most extensively used. This modern suspension insulator unit has been developed from operating experience, and at the present time appears to be a reliable unit when used in short strings, or those composed of eight units or less. When the string length is increased beyond eight or nine units, the placing of additional units in the string does not materially reduce the voltage duty of those units next the conductor.

There are at present several methods of solving this insulation problem. One method is that of a larger unit than the common 10-inch disc, or a unit that will be capable of carrying a higher voltage duty; in other words, a suspension insulator such that when operating in a short string will still permit the various units comprising the string to carry a voltage well within their safe operating limits. This method of making larger units is not favored by a large majority of the porcelain insulator manufacturers, nor by most transmission engineers, as the present 10-inch cap and pin type porcelain insulator unit is the product of over ten years of experiment and development based on actual experience, and there are numerous factors entering which would be

No. 1. 9-unit string of 10-in. insulators. 5¾-in. spacing. Insulators hung from end of cross-arm; regular hardware; upper 17 ft. of tower; line conductor increased to 2½ in. diameter to lower corona loss from conductor when producing flash-overs with oscillator; 30 flash-overs; about 10 clear and 20 cascades.

No. 3. 15-unit "V" string; 10-in. discs; 5¾-in. spacing with double disc and ring shields and 3-in. sphere mounted as a part of the shield assembly with its center about 3.5-in. above the upper edge of the shields. 30 flash-overs; 2 struck into the insulator strings; a few struck to the tower sides; most struck upwards centrally to the cross-arm widely free of the insulators.

No. 5. String of 12; 5¾-in. spacing; 10-in. suspension units equipped with 2½-in. x 26-in. ring shield; 30 flash-overs; one or two cascades occurred over the three top units. Distances between:

Ring and left side of tower..... 85″
Ring top and cross-arm..... 71″
Ring top and center of conductor, 14″

No. 2. Same as No. 1 except that upper and lower arcing horns have been removed. 9-unit string of 10-in. insulators, 5¾-in. spacing. Insulators hung from end of cross-arm; regular hardware; upper 17 ft. of tower-line conductor increased to 2½-in. diameter to lower corona loss from conductor when procuring flash-overs with oscillator. 30 flash-overs; 8 clear and 13 cascades.

No. 4. Same as No. 3 except that the center 3-in. sphere was raised 6¾ in. above the middle edge of the shields. 15-unit "V" string; 10-in. discs; 5¾-in. spacing with double disc and ring shields. 30 flash-overs; all centrally upward to cross-arm, widely clear of the insulators.

No. 6. 14 Hewlett type insulators with cylinder shields; 4-in. x 12-in. parallel to conductor; top surface of cylinders on level with under side of third unit. Oscillator flash-over tests: 60 and 75,000 cycles. 30 momentary applications; distribution: 30 flash-overs; 4 flashes. Frequently a group will divide into two or more sub-groups, each developing a different discharge route.

No. 7. Same as No. 6 except that the shields and their supporting pipes are removed. Conductor supported with 1-in. clamp and covered with 2½-in. galvanized iron tubing. 30 momentary applications; 30 flash-overs; 2 to top of string; 13 flashes in air; balanced to tower.

No. 8. 14 insulator string composed of 4 Hewletts and 10 cap and pin type units with Hewlett insulators at top of string or next to tower. Shields 24-in. x 4-in. cylinders opposite third unit from line conductor. 30 oscillator contacts; 28 flash-overs to cross-arm; 4 to lower; no cascades.

No. 9. Insulator string same as No. 8. Shields were vertical, 12-in. x 2-in. cylindrical and capped with 30-kv. pin insulators. 30 oscillator contacts; all produced flash-overs to side of tower or lower cross-arm with the exception of one that went to cross-arm remote from insulator.

difficult to control in the larger unit, and if any one of these factors were not properly taken care of the results would be serious.

Another method would be to grade the size of the units in an insulator string to give equal voltage distribution. In such method some of the units would have to be large. Certain difficulties would be introduced thereby, viz., the difficulties of manufacture and of using different unit sizes placed properly in the string.

The most logical scheme for developing a 220-kv. insulator seems to be that of utilizing the present 10-inch unit, which has been developed after years of experience, but providing means to properly take care of the voltage distribution throughout the string, this being necessary when more than eight or nine units are used. It is evident that from twelve to fifteen 10-inch units should be used for the insulation of a 220-kv. line, the number being determined by the factor of safety desired. The character of the unequal voltage distribution among the units of a long insulator string is due to the difference in capacity between the various units and ground. The first unit next the conductor must carry the charging current for all units, together with the current to charge the condensers between the caps of the remaining units and ground. The second unit from the conductor is relieved of carrying the charging current for one of these ground capacities; the third unit, two, etc.

A large amount of experimental work has been done to develop a suitable form of shield for use with standard units. Laboratory studies have been made of the effect of the presence of few or many defective units occurring in all possible positions in the string. The forms and manners of mounting of the shields so as to limit the maximum unit voltage duties to values less than those which have been found satisfactory for the insulation of lower voltage lines and to control the routes of discharge through flash-over under excessive voltage have been studied in such manner as to minimize damage to the insulator string.

The effects upon unit voltage duty and flash-over discharge routes have been studied in composite strings made up of units having low and high capacity. A certain amount of grading occurs in strings of this class.

Special strings and their shields have been studied in relation to tower clearance limitations; they have included V-strings and hold-down strings.

In making these voltage duty and flash-over studies the strings were invariably mounted in place upon models of transmission towers that were full sized except as to height—a matter wherein the results would be affected only slightly.

In closing, the Committee wishes to express its appreciation for the interest taken and help rendered in this work by the Southern California Edison Company, the Pacific Gas & Electric Company and Mr. F. G. Baum; also for the continued help and guidance of Professor H. J. Ryan.

Respectfully submitted,

PROF. H. J. RYAN,
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J. A. KOONTZ, Chairman.

ELECTRIC MINE LOCOMOTIVE HAS LONG SERVICE RECORD

An electric mine locomotive that has a unique record for longevity and service is at present operating in the mine of the Union Pacific Coal Company at Rock Springs, Wyoming. The locomotive was built by the Thomson-Houston Company and was put in service at its present location

Electric mine locomotive twenty-seven years old that has a record of more than five and a half million ton miles.

twenty-seven years ago. It has been giving continuous service ever since, records kept by the Union Pacific Coal Company showing that it has hauled 3,712,500 tons of coal over an average distance of 1.5 miles in that time, or a total of 5,568,700 ton miles.

Owing to delays in the preparation of some of the N. E. L. A. papers it was impossible to publish all of them in this issue. The remainder will appear in the June 1st issue.

Better Industrial and Commercial Lighting

BY R. M. ALVORD

(Better illumination as a boon to industrial plant, office, store and home was thoroughly covered by one of the Pacific Coast Section N. E. L. A. papers of last year. The specific ways in which the better lighting campaign may, and does, benefit the electrical industry itself are taken up in this paper presented to the 1921 convention of the Pacific Coast Section by the lighting division of the Commercial Committee.—The Editor.)

As an avenue of new business for those who get their bread and butter from the electrical industry, better industrial lighting offers exceptional possibilities. The survey of 1600 manufacturing plants in the east and middle west, briefly referred to in the paper entitled "Better Illumination and What It Means to the Business Man and Factory Owner" has shown that more than 50% of the manufacturing plants in the country are badly in need of better lighting, and that artificial lighting is needed in factories during 25% of the time they are operated. The result of this survey assures a wide and fertile field to those who will aggressively promote this better lighting service idea, and, with it, the sale of lighting and supply equipment essential to proper lighting installations.

Lighting exhibit installed in the Chamber of Commerce rooms at Los Angeles by the California Electrical Cooperative Campaign. Lectures and demonstrations on industrial and commercial illumination are given twice a month. The public is welcome at all these lectures.

The individual branches of the industry are directly benefitted as outlined below:

1.—Power Company

An increase in current consumption is obtained, but probably more important is the lowered cost of service through the elimination of dissatisfied lighting customers.

2.—Contractor-Dealer

New industrial lighting, properly installed, will usually mean a little larger job and a little more profit to the contractor-dealer.

Probably the main source of increased volume of business for the contractor-dealer is the remodeling of old and inadequate lighting installations.

The contractor-dealer lamp business will show a decided increase on account of the fact that adequate lighting installations will involve more and larger lamp units.

The standardization of a better design of lighting fixture units, together with the increased sales activities on this class of material, will result in a lower percentage of overhead expense, and a better turnover, both of which mean better profits.

Probably the greatest advantage or benefit to the contractor-dealer is to be derived, first, from prospects who give him lighting business because they find him well equipped to handle it, and, second, from satisfied customers who bring him more business in this and other lines, directly and through their friends, because of the good lighting installation which the contractor-dealer has installed.

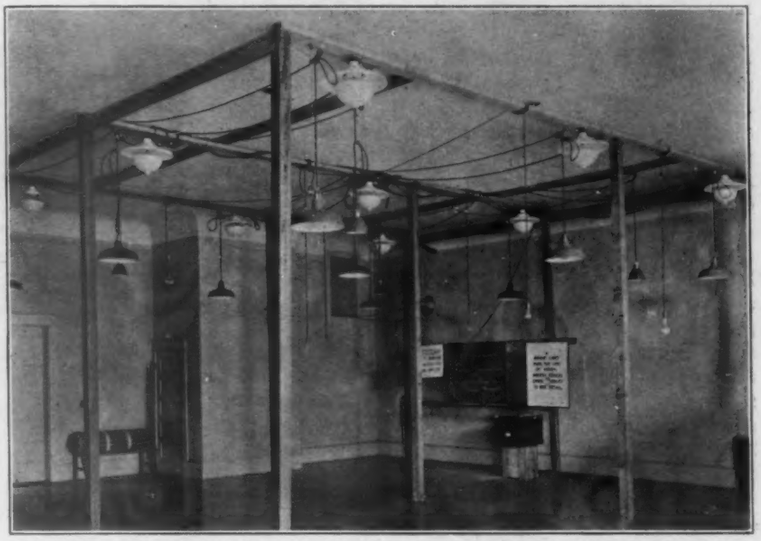
The contractor-dealer who is well equipped with a foot-candle meter and a knowledge of how to solve the usual lighting problems will so inspire the prospect with confidence in his ability to do the right kind of a job that nine times out of ten his less well informed competitor will be eliminated.

3—Jobber

The jobber profits by better illumination in several ways. First, he will enjoy an increased volume of sales on construction and schedule material, as well as on lighting equipment. He will show a decreased investment and increased turn-over due to standarized lighting units. He will show a smaller credit loss, as his contractor-dealer customers will be placed on a better profit-making basis by intensive sales effort on lighting equipment.

4—Manufacturer

The manufacturer will profit in direct proportion to the increased prosperity of other branches of the industry. In addition to this, there will be available for the manufacturer of electrical machinery some additional power company business because of the load added to the power company's lines. Likewise, the manufacturer of power company supplies will profit.



Portable traveling exhibit used by the California Electrical Cooperative Campaign to demonstrate good and bad lighting in the larger California towns outside of San Francisco and Los Angeles. Lectures and demonstrations are conducted nightly during one week in each town.

Just how much each branch of the industry is directly interested in this tremendous educational campaign is shown graphically by the accompanying chart which was prepared by the Lighting Exhibit Boosting Committee of the San Fran-

cisco Electrical Development League. This chart is based on an installation of 28—300-watt units with bowl enameled Mazda C lamps and RIM reflectors so spaced as to produce 10 foot-candles of illumination. For convenience' sake, the cost values are reduced to a unit basis per kilowatt of connected load. The figures used are the costs to the industrial plant and are based on the average market prices made by contractor-dealers. These values include all costs back to the service connection.

The sales of each of the branches of the electrical industry for each new kilowatt of lighting load connected is as follows:

Contractor-dealer	$106.00
Jobber	78.75
Power company	1,000 kw-hr. per year
Lamp dealer and manufacturer	$11.30 worth of lamps per year

These last two maintenance values are based upon the fact that each socket installed in an industrial plant on the average burns out one lamp per year, which means, in the case of a 1,000-watt lamp, a consumption of 1,000 kw-hr. per year.

The Better Lighting Campaign

Organizations and groups of leaders in our industry are making tremendous efforts to bring to users of light a message of its importance to them. Lighting exhibits are being installed in all of the principal cities of the country. Traveling exhibits are being sent around to the various smaller communities which are not accessible to the permanent exhibits.

In California, under the auspices of the California Electrical Cooperative Campaign, there are two permanent exhibits, one in San Francisco and one in Los Angeles, and a traveling exhibit, which has been visiting the cities of our valleys. There has been other educational work carried on by manufacturers' organizations, but at the date of writing this paper the electrical industry in California is not showing the thorough, enthusiastic cooperation that the results to be obtained seem to justify. Many members of the electrical industry have not even themselves visited these lighting exhibits, and only a very few are making any effort to have managers and superintendents of commercial and industrial houses see the exhibits.

Enough information has been received regarding new lighting business placed by industrial plants whose managers and superintendents have attended the exhibits to demonstrate that the exhibits will sell the better lighting idea and develop substantial new business for the electrical industry almost in direct proportion to the number of factory and business house managers who attend. It is evident, therefore, that a wonderful expansion in industrial and commercial lighting business is within the reach of our industry. It simply requires that 100% attendance of men responsible for the lighting of stores, offices and factories be secured for these exhibits.

Before this result can be secured the members of our own industry must be thoroughly sold and enthusiastic, first, regarding the value of better lighting, and, second, regarding the effectiveness of these lighting exhibits.

How to Organize Lighting Demonstrations

To sell the idea to our own industry and then to the public, the industry in each city or town where a lighting demonstration is being held should be organized to promote, systematically and aggressively, attendance at these exhibits. Committees must be appointed, each being assigned the responsibility of securing attendance at a particular meeting, or of a particular class of industrial or commercial plant managers. The detail plan of this organization may vary in the different cities, but in connection with it the following responsibilities for the power company, the contractor-dealer, the jobber and the manufacturer, respectively, should be definitely understood and fulfilled:

The Power Company

As indicated by the above chart, the power company is interested in every kilowatt of new lighting load connected to the extent of 1000 kilowatt-hours per year. Except in few instances, this is off-peak load.

As the power company, perhaps more than any other branch of the industry, has the full confidence of the users of electricity, it is in the best position to influence the kind of lighting to be installed. This it can do by having on its staff men who are competent to give proper advice about lighting.

It should take an active interest in the lighting exhibit, and through it and other means keep all employes informed as to the progress of the better lighting campaign. The commercial manager should insist that his solicitors attend the various lectures and also study the literature that is available on the subject, so as to be able to give complete information to customers.

Collectors and meter men can help promote the better lighting idea by taking notes on the condition of lighting on the premises which they visit, and by reporting such cases as seem to need better lighting to their commercial department. The commercial department can then properly present the subject to the customer whose plants or offices are so reported.

Another view of the Los Angeles lighting exhibit showing the control and indicator boards, shadow box and other apparatus used to demonstrate the fundamentals of good lighting.

Industrial and commercial lighting exhibit, Safety Museum, 529 Market Street, San Francisco, installed by the California Electrical Cooperative Campaign in cooperation with the Industrial Accident Commission

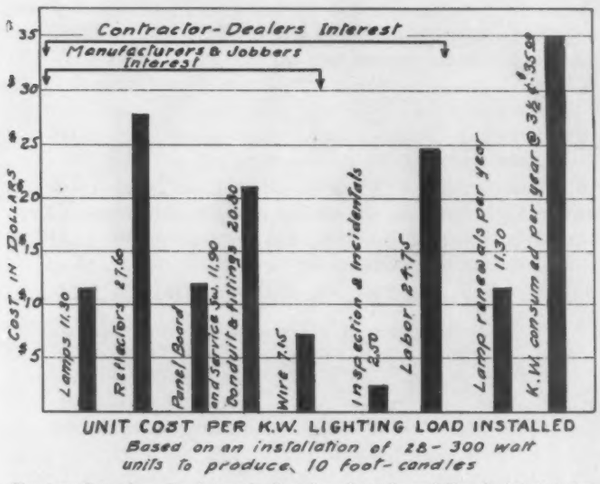


Chart used to show the interest of various branches of the electrical industry in a typical industrial lighting installation.

The Contractor-Dealer

The contractor-dealer should:

First, attend as many of the lectures as possible and make an endeavor to take one prospective customer, or more, to each lecture. Enthusiasm can best be transmitted by personal contact. Much can be done by a series of circular letters and other publicity, but after all is said and done, personal contact is necessary to thoroughly arouse the prospect's interest in his lighting problems. Therefore, the contractor-dealer should see that every prospective customer in his community visits the exhibit and witnesses a demonstration.

Second, insist that all of his employes attend the exhibits as regularly as possible and that all employes advertise such exhibits to all customers and prospective customers.

Retail salesmen in contractor-dealer establishments should make it their business to be thoroughly equipped to talk and sell better illumination. This can best be accomplished by combining two methods; namely, the regular attendance at exhibits and lectures, and the conscientious study of pamphlets issued by manufacturers of incandescent lamps and of illuminating equipment.

The superintendent of construction of the contractor-dealer must tie-in with the campaign to make it a success. He is more closely associated with the customer, and on account of his position he is able to preach the gospel to better advantage than any man within the industry. He should become equipped to talk better illumination, and should follow the procedure outlined above in getting this data.

The house-to-house appliance solicitor of the contractor-dealer should also be informed regarding the advantages of better lighting in industry, in the home, in the office, etc., and should be coached to turn in prospects for such better lighting to the contractor-dealer whom he represents. The appliance solicitor should not be permitted to make lighting specifications unless the contractor-dealer employing him is well satisfied that the solicitor is thoroughly competent to do so.

Third, insist on installing better illumination on those jobs on which he has influence.

Fourth, tie-in more directly with the campaign by seeing that his own place of business is properly equipped with modern illuminating units of ample size and that those units are kept in a condition of maximum efficiency; also by a judicious use of lighting window trims and newspaper advertising. This advertising can be of a cooperative nature, such as was carried on by twelve San Francisco contractors.

The manufacturers of lamps and lighting equipment are prepared to furnish contractor-dealers and power companies handling their product with considerable literature in the form of letters to consumers, blotters for school use, cards for street car advertising and for dealers' stores and show windows. Both contractor-dealers and power companies should make every possible use of this material, sending out special circular letters, etc.

Fifth, the contractor-dealer should not overlook the smaller stores and factories. They need better lighting as well as the larger establishments, and in the aggregate they offer a greater potential business. The large department store or factory, with 500 or 1000 employes, looms big on the horizon as an opportunity for quick and extensive results. But many small drug stores, groceries, shoe repair shops, garages and machine shops taken together make a larger volume at a better profit because this business can usually be had without competition. Every contractor-dealer can count many such concerns as his regular clients. From these concerns orders for better lighting installations can generally be secured without competition by simply furnishing them with proper recommendations and a simple estimate of cost. These orders may be but "little drops of water and little grains of sand," but it is principally of these that the mighty ocean of electrical sales is made. For a larger volume of profitable business the contractor-dealer should concentrate on the small, as well as on the large, establishments.

The Jobber

The jobber should insist that the members of his selling organization attend the exhibits and lectures regularly. His salesmen should advertise the exhibits to their customers. They should always talk the merits of better illumination, and should at all times be ready to assist their customers in closing orders for lighting equipment. They should furnish contractor-dealers with tips on live prospects.

The jobber should have his entire establishment completely equipped with modern units so that his place of business can be used as a model by contractor-dealers in the closing of deals. He should inform all contractor-dealers that his place of business is at their disposal for this work.

He should furnish contractor-dealers and power companies with the latest information on lighting.

The Manufacturer

The manufacturer can further this campaign by keeping members and employes of other branches of the industry informed of new products on the market and about to be placed on the market. He should have a complete mailing

Industrial Hazard
Better Lighting Speeds Production
Short Winter Days
More light on industrial profits
Demonstration of Industrial Lighting
These Firms Install Scientific Industrial Lighting

Cooperative advertisements which were run in San Francisco newspapers by fourteen contractor-dealers who were specializing in industrial installations.

list and should see that everyone on this list is supplied with the latest data on proper and adequate illumination.

It has been pointed out that it is necessary for the contractor-dealer and the power company to have men in their organizations who are adequately equipped to make lighting

recommendations to meet the requirements of the average factory, store or office. The manufacturer should recognize that with his laboratory and his corps of electrical engineers who are continually studying this subject, it is his problem to furnish necessary educational literature to the contractor-dealer and to the power company to whom he distributes his product.

The manufacturer should also be ever ready with lighting specialists to assist the contractor-dealer, the power company or the customer with the study and solution of unusual lighting problems.

The California Electrical Cooperative Campaign

In addition to the other promotion activities in connection with these exhibits, the California Electrical Cooperative Campaign should make further efforts to interest architects in the lighting engineering services which they may secure through contractor-dealers, power companies, jobbers and manufacturers. An effort should also be made by the Campaign to tell the story of better lighting and what the electrical industry is doing to promote better lighting to oculists, to nurses of schools, and to other groups and organizations that are interested in the welfare of the child and of the workman. The story of the advantages of better lighting should also be carried into our schools and colleges.

In order that all may know the result of the work for better lighting, it has been recommended that the California Electrical Cooperative Campaign make a survey every three months by sending a questionnaire to manufacturers, jobbers, contractor-dealers and power companies, thereby collecting as much information as possible regarding the actual results in new installations, sales, etc.

Finally, let us remember that "everyobdy's job is nobody's job," and that the final success of this activity of our industry depends on thorough organization in which each individual or group of individuals has its particular task to do and **does it.**

Committeemen: R. M. Alvord, Chairman; H. L. Miller, Tracy Simpson, John Jones, C. C. Hillis.

What Better Illumination Means to the Business Man

BY A. W. CHILDS

(The dollars and cents value of good lighting to the industrial and commercial world is one of the most potent factors in its promotion. This paper by the lighting division of the Commercial Committee, presented to the Pacific Coast Section N. E. L. A. Convention, brings out the real economic saving involved in scientific lighting.—The Editor.)

The "nigger in the wood-pile" of present-day manufacturing is overhead expense. How to reduce this and lower production costs is a man size problem. Better illumination not only offers a means of reducing such sizable fixed charges as spoilage, factory seconds and compensation insurance premiums, but, in addition, presents possibilities of increasing output worthy of close study by the factory manager.

The best workmen cannot work in the dark. Unless they have good lighting to see by, defective material may travel through the manufacturing process only to be rejected as a partial or total loss at final inspection. Other spoilage results from mistakes and inaccuracies if workmen cannot see distinctly and quickly. According to Floyd Parsons, who writes "Everybody's Business" for the Saturday Evening Post, 25% of factory spoilage is due to inadequate illumination. Every factory manager has a fairly accurate record of his past spoilage. With this percentage in mind and last year's spoilage record at hand, it is a matter of simple arithmetic to compute in dollars and cents the spoilage waste chargeable to lighting expense.

In 1910 it was definitely established by careful investigation of insurance statistics that about 24% of all industrial accidents were due to glaring and insufficient lighting. Because of the development in the art of illumination and the attention given to safety-first work, since then this high percentage has been reduced.

Industrial Accidents Due to Bad Lighting

Mr. R. E. Simpson, a lighting engineer of considerable experience in the study of the relation of lighting to industrial accidents, and who has spent ten years on compensation insurance work with the Travelers Insurance Company, estimates that today 15% of industrial accidents are caused directly or indirectly by bad lighting. In a paper entitled "The High Cost of Poor Lighting," read before the 1920 Convention of the Illuminating Engineering Society, he cites an interesting, concrete example to show how the accident factor influenced by bad lighting may increase the compensation insurance premium, an increase which should rightly be added to the bill for lighting as an item of overhead expense. He selects a factory with 1000 employes, earning $40.00 a week each, which makes an annual payroll of $2,080,000; 100 watts of lighting improperly used is allowed each workman. It is assumed that the lamps burn three hours per day, 300 working days per year. At a rate of $.05 per kw-hr., the lighting bill is $4,500 per year, or $375 per month.

Speaking of compensation insurance premiums, Mr. Simpson's own words, as an insurance man, should be of particular interest to the factory managers. He says:

"Compensation insurance premiums are based on the amount of the payroll, and the rate is determined by the accident experience of a given industry, modified by the experience of the particular plant under consideration. With a rate of one per cent, the premium in the case under consideration would be $20,800. The insurance carrier might pay the claims resulting from two accidents per month (on an average), and meet their own overhead costs, and still have a slight margin of profit. An experience of three accidents per month, one-third of them due to poor lighting (a not unlikely event), would leave the insurance carrier no option but to increase the rate by 50%. The premium would then be $31,200—an increase of $10,400, or an average of $866 per month.

"We see, then, that the factory owner, in this example, is paying the utility company $375 per month for illumination, and the insurance carrier $866 per month (or nearly two and one-half times as much), because that illumination is not sufficient to permit his employes to work in safety. The cost of his illumination is therefore increased to $1,241 per month on account of this one item.

"Manifestly, this is not a happy condition for any of the parties concerned. As a representative of an insurance carrier, I can say with good grace that we sincerely desire to prevent accidents, and in fact this is an important part of our business. The triple purpose of actuating this work is (1) to reduce accident claims, (2) thereby reducing the premiums, and (3) reducing suffering."

Proper Illumination Increases Output

As has been pointed out, better illumination offers a direct means of reducing spoilage, factory seconds and compensation insurance premium, but it has been demonstrated beyond a doubt that it is an exceptionally inexpensive means of directly lowering production costs by increasing output. Substantial evidence of this was obtained by some tests made in Chicago by the lighting engineers of the Commonwealth Edison Company, during 1918.

Illumination of the packing floor in the main building of the "Sun Maid" raisin packing plant at Fresno, California.

Another night view of the Sun Maid raisin packing plant. Note the even distribution of the light, and the absence of glare and sharp shadows.

In conjunction with plant managers of a carefully selected list of industrials, competent lighting specialists of the Commonwealth Edison Company took a record of production for a 30-day period with the existing lighting equipment. The lighting was then changed to modern equipment, giving productive intensities, and a record of production taken for a 30-day period, keeping all other variables as nearly constant as possible. The results of these tests have been published in practically all of the trade journals during 1918 and 1919. It is not necessary, therefore, to reproduce the results of these tests here except to say that an increase in production of from 6 to 30% was obtained at an increased cost for lighting that amounted to but 1 to 6% of the payroll.

It was the intention to revert back to the old lighting and run a check test for a period of 30 days to see if the output would drop back to the old level. But it is a significant fact that in each case the factory superintendent refused to allow the old system to be re-installed because of the loss of much needed production which they felt would result. If such an increase in production was possible at such a small cost and with little trouble in a few plants in Chicago, the lighting industry reasoned that the same thing could be done elsewhere.

A Survey of Industrial Lighting

In order, therefore to find out what the actual conditions were in industrials generally, a survey was made. Trained observers were set to work to visit factories situated over a wide area. More than 1600 plants in 15 states located in the East and Middle West, the industrial center of the country, were visited and a careful record taken of actual lighting conditions. Among other things, it was found that 50% of the plants visited had obsolete lighting installations and were badly in need of better illumination. The same survey also showed that 25% of all factory work is done under artificial illumination. The amount for different plants varied between 5 and 90%, but the average of all the plants investigated was 25%. The character of lighting, therefore, in the average manufacturing plant affects 25% of the factory's total output. As the lighting equipment of the factory is just as important a part of its machinery of production as a motor or the machine it drives, efficient manufacturers will look well to their lighting.

As an indication of how important the banker considers good lighting, the remarks of Mr. C. W. Banta, vice-president of the Wells Fargo Nevada National Bank of San Francisco, may be of particular interest. He stated before a recent conference of directors and members of the California Industries Association, that the amount and character of lighting in a merchant's establishment or factory determined to a considerable extent the efficiency of a business house or industry, and that to display goods effectively or manufacture efficiently, good lighting was necessary. Without the proper amount or quality of illumination, the merchant or manufacturer was handicapped in competition with others in his line and for that reason would be less liable to meet his obligations promptly.

The above facts point to the importance of lighting from a manufacturing and merchandising standpoint and the attitude of plant managers in Chicago shows conclusively that the demonstration method, or "seeing is believing," was the one best way of convincing them that it was advisable to look to their lighting.

Demonstrating Good Lighting

For the lighting industry actually to demonstrate, by trial installations in individual plants, the effect of good lighting upon output and production costs, would have meant a tremendous expense and an effort which present-day conditions would not permit it to make. In searching for a practical means of bringing this message of increased production to the manufacturers, a demonstration idea whereby comprehensive lighting exhibits could be located in the industrial cities, where they would be accessible to the plant managers, was hit upon. The first of these lighting exhibits were installed at Cleveland, Ohio, and Harrison, New Jersey, and a third one at the 1920 National Electric Light Association Convention in Pasadena, California. These three exhibits were received with such enthusiasm by the lighting industry and factory managers who were privileged to see them, that today permanent exhibits are being installed in all of the large industrial cities of the country and portable traveling exhibits are being sent out to the smaller communities not readily accessible to the permanent exhibits. The users of light are being invited to attend these demonstrations where the difference between good and bad illumination is shown by actual examples. These lighting exhibits reflect the lighting industry's endeavor to serve its patrons by showing them how its service can be of most value to them. It offers the factory man an opportunity to see the next best thing to an actual demonstration in his own plant.

In California this educational campaign has taken definite shape under the leadership and direction of the California Electrical Cooperative Campaign. Lighting exhibits have been installed in the Safety First Museum of the Industrial Accident Commission at 529 Market Street, San Francisco, and in the Chamber of Commerce rooms of Los Angeles. In both these exhibits, a lecture and demonstration is given every week by members of the Illuminating Engineering Society. Those interested in illumination are invited to at-

tend and see demonstrated the difference between good and bad lighting.

A semi-portable exhibit is also furnished by the California Electrical Cooperative Campaign to the larger cities of the state. The field representative of the Campaign committee is in charge of it and gives the lectures and demonstrations. At the time this is written the traveling or semi-portable exhibit has been installed and demonstrations given in Sacramento, Stockton and Modesto. From Modesto, it will go to Fresno, Bakersfield, then south of the Tehachapi and back again by way of Santa Barbara, San Luis Obispo, Watsonville and San Jose. The exhibit remains in each town one week. Invitations to see the demonstrations are sent out to all industrial and commercial users of light in each of the towns.

An Opportunity for Commercial and Industrial Men

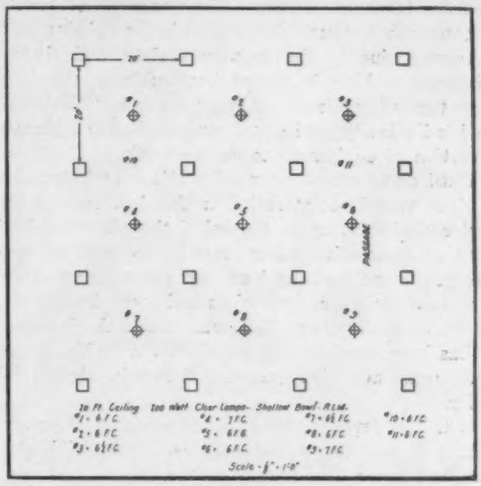
In this way, the California Electrical Cooperative Campaign is giving the store and plant managers and their employes an opportunity to study first hand, without expense to them, the progress made in lighting equipment and the difference in good and bad illumination. It is doing more than that. By these exhibits and the demonstrations by trained engineers, the Campaign is teaching the electrical contractor-dealers and the electricians who install lighting equipment, as well as the architects, construction managers and contractors upon whom to a large extent building owners rely for advice, what constitutes good illumination, what it means to the business man or factory owner and how it should be installed so that they will be competent to carry out the wishes of the owner in designing or installing the right kind of lighting.

Every business man, every factory manager or owner can learn something of a practical nature about one means of stimulating his business, increasing his production and stopping the drain on his profits by spoilage, high labor turnover and discontented workmen if he will but spend an hour at one of these exhibits. And if he decides that better lighting will aid him in the work of his office, store or factory, he will find the electrical industry well equipped to solve his particular lighting problem. Either the competent electrical contractor-dealer or the properly organized power company will be able to recommend the best lighting plan in the majority of cases. Back of the contractor-dealer and the power company, who are the direct contacts of the electrical industry with other industries and other users of electrical service, is the jobber with his lighting specialist and the manufacturer with his lighting specialist, his illuminating engineers and his laboratory. The lamp and reflector manufacturers have prepared carefully-studied-out tables showing how to design an ordinary lighting installation and have supplied them to all power companies, jobbers and contractor-dealers. In addition, pamphlets giving the results of careful studies on the lighting needs of certain manufacturing processes are supplied to those who desire them. And then the lighting specialist of the manufacturer or of the jobber is always available to assist the contractor-dealer or the power company in the special study of unusual or difficult lighting problems and to furnish the results of their special study to the factory, office or store manager, as well as to either the contractor-dealer or to the power company.

The electrical industry therefore is not only desirous, but is also capable, of helping users of its service to obtain the maximum result for every expenditure, and so the plant, store or office manager is assured of competent assistance in the study and solution of his lighting problem if he will consult with his electrical contractor-dealer or with the power company that serves him.

Standardization of Lighting Equipment

Another need has been for the standardization of lighting equipment. Perhaps no industry has moved along the road of progress any faster than the lighting industry. As a consequence, new developments have followed each other in rapid succession. Lamp and reflector manufacturers, in developing their own lines, worked more or less independently of each other. As a result, there was a wide variety of reflectors designed for particular uses and for certain lamps. This had the effect of bewildering users of lighting equipment. Realizing this, the reflector and lamp manufacturer's engineers conferred and drew up a standard specification for reflector equipment which would insure proper lighting service with the new high powered Mazda C lamps. Reflectors manufactured under these specifications are known as the



Lighting layout showing arrangements of lighting units in illustrations on opposite page, and foot-candle intensities of stations marked. This is a good example of general illumination for a packing plant or any other industrial where similar conditions prevail, not requiring a high intensity. This illustrates also the beneficial effects, from a lighting standpoint of light colored walls and ceilings, which in addition to increasing the efficiency of the lighting installation present a cheerful, clean atmosphere. It is commonly recognized that cheerful surroundings in an industrial plant affect quality and quantity of labor output.

RLM Standard Dome, the letters "R-L-M" standing for "Reflector" and "Lamp Manufacturers." All reflector manufacturers desiring to manufacture this standard dome reflector and use the RLM Standard Dome label on their product must submit periodically a percentage of their product to the Electrical Testing Laboratories, a neutral testing agency, for test to see whether it meets the RLM Standard Dome specifications. Practically all of the leading reflector manufacturers manufacture this standard product, which is designed to give maximum efficiency and diffusion with a minimum of glare. This design of reflectors when properly used will meet about 90% of industrial lighting needs.

This is further evidence of the work of standardization and education by which the electrical industry has prepared itself to readily design and install lighting installations that will give real lighting service to their users.

And all of it is an important work, worthy of a great industry so vital to business and industrial progress. It is being carried on in the interest of service to those who use artificial light, with the full realization that the electrical industry can profit only to the extent that it intelligently and usefully serves its patrons.

Committeemen: A. W. Childs, Vice-Chairman; W. G. Wilson, C. D. La Moree, C. O. Chamblin, W. W. Shuhaw.

Industrial Electrical Heating

BY A. E. HOLLOWAY AND H. L. GARBUTT

(The great majority of industrial processes require the application of heat at one or more stages and in varying degrees of intensity. The flexibility, cleanliness and safety of electric heating are putting it in the front rank for industrial purposes such as those discussed in this report of the committee on industrial heating to the Pacific Coast Section of the National Electric Light Association.—The Editor.)

Low Temperature Industrial Heating

Heating by means of electricity is today common in many industrial establishments, and due to certain qualities is proving very popular. Industrial heating is one of the largest fields which the central stations have for the increased sale of energy, and the rapidity of the application of electricity for this purpose will depend greatly upon the central stations and manufacturers. The progress of development will necessarily be much slower than in the lighting and power departments, due to the greater variety and character of installations making it almost impossible to standardize on any one type of appliance. Almost every installation must be treated individually, and great care used in the planning and construction of equipment to do the work.

Until quite recently central stations and manufacturers have given very little attention to the development of industrial electrical heating, in the belief that it would be impossible to compete with other fuels in the cost of operation. As the power and lighting loads were increasing rapidly, the path of least resistance was taken and these developed instead of the industrial heating. However, within the last few years there has been considerably more activity in the progress of heating, until now demands are found in almost all communities.

With the development of large amounts of water power in California and the western states, industrial heating will eventually become a big factor in the sale of energy. Loads can often be secured that will materially fill the valleys of the central station load curves, as much heating can be done at off-peak times.

Your committee in order to prepare a report on this part of the industry has for convenience divided the subject into two parts, as follows:

Industrial Heating

(1) Low Temperature Industrial Heating
- (a) Bake ovens
- (b) Enameling ovens
- (c) Core baking ovens
- (d) Paint drying
- (e) Miscellaneous uses.

(2) High Temperature Industrial Heating
- (a) Electric brass furnaces
- (b) Electric steel furnaces
- (c) Miscellaneous uses.

The uses for low temperature heating are more numerous than those for high temperature. However, the higher the temperature of operation, the more efficient the use of electrical energy becomes in comparison to its competitors. This is due to the fact that other fuels need a greater amount of ventilation as the amount of discharged gases varies practically in direct proportion to the amount of heat required. Where comparatively low temperature processes are used, electric energy has greater competition on account of its greater cost.

The consensus of opinion has always been that it was necessary to make an especially low rate for energy sold for industrial heating purposes, in order to compete with other fuels. This idea, however, has been proved wrong, and it is now known that many of the industrial heating applications can be accomplished economically at rates as high and even higher than those charged for power purposes. This is due to the great flexibility in the application of electric energy. Some of the advantages which enable the use of electric energy for industrial heating to compete with other fuels at even lower cost are:

1. Cleanliness
2. No products of combustion
3. Automatic control of temperature
4. Elimination of fire hazard
5. Ease of application
6. No objectionable gases
7. Ease of operation
8. Uniform product, due to uniform heating rate
9. Efficiency

One or more of the above advantages are brought into play in each individual installation, and this makes the use of electric energy superior to any other fuel.

Take, for an example, the electric bake oven; it is clean, easily controlled, efficient, and produces a uniform product. The glue pot's superior points are control of temperature, elimination of fire hazard and ease of application. The enameling ovens have the advantages of cleanness, absence of products of combustion, automatic control and ease of application. We could go on indefinitely showing the superiority of the electrical over any other method of heating. However, we will take one or two of the appliances well developed.

The Electric Bake Oven

(a) Cleanliness

The public is beginning to demand more sanitary conditions in bakeries and restaurants. As far as cleanliness is concerned, the electric oven is without a peer. As there is no combustion, fumes are eliminated, oxygen is not consumed and the air is not vitiated. No soot is deposited upon the goods, as is often the case with other types of ovens. The fire and explosion hazard is eliminated—a very essential point when the equipment is used in hospitals. There are no oil tanks, fires, wood, coal bins, dust, ashes, or dirty flues. Although many electric ovens are provided with vents, in most cases it is not even necessary to connect them with flues.

(b) Convenience

One of the most common types of electric oven on the market today has three to four decks. Above and below each deck a heating element is placed, controlled by a three-heat switch. Each shelf is therefore independent in its control and can be operated at different temperature, thereby baking foods requiring different temperatures at the same time. Nothing could be more simple than the control of the oven, as a turn of the switch raises or lowers the amount of heat required either above or below each deck.

Theoretically, the heating capacity of the element is calculated so as to allow more heat in front, to compensate for the opening of the doors, and progressively less heat from the bottom to the top decks, to allow for the tendency of the heat to rise. The elements are spaced evenly over the deck area and are built of resistance wire, wound on tubes of porcelain composition. Much of the heat wasting, time consuming labor of changing the position of the goods on the shelf, so that they will bake evenly is eliminated, and although there is less changing of the position of the goods required in

the electric ovens than its competitors, it is often necessary to change the position to get uniform results.

In many instances the kitchen is over-crowded, so it is very convenient for the oven to be located in the basement or some unused room away from the main kitchen. As no flue is required and the problem of fuel supply is solved by simply connecting the oven to the power wires, the electric oven is especially adapted for such cases.

When used in the kitchen many inefficient types of ovens throw off so much heat that the room temperature is raised to such a high degree that the cooks are uncomfortable and dissatisfied. The electric type was substituted in one such instance recently and the manager stated that this advantage alone was worth the price of the oven as it reduced the kitchen temperature about one-half and did much to solve his help problem.

(c) Operation

The oven is brought up to baking temperature in from one to two hours. For pastries the oven can be used continuously. A 60-loaf size will keep three bakers busy preparing and baking pies. The moisture content of the bread, however, is so great, that after unloading, it is necessary many times to wait for the temperature to "pick up" before putting in the new goods. It would seem therefore that a 20 to 30% increase in the heating capacity of the ovens now manufactured would be beneficial for bread making. It would then not be necessary to lose the time for the temperature to "pick up" before starting to bake the next batch of bread. In this way one of the main objections which bakers now have to the oven would be removed.

(d) Economy

The cost of operating the electric oven is very reasonable, in spite of electric energy costing from four to ten times as much per heat unit as competing fuels. This high economy is, of course, due to the oven walls being thoroughly insulated so that "the efficiency of utilization" is much higher than any other common type of portable oven. The fuel cost, with electricity at 3 cents per kw-hr., will be between 2 and 3% of the value of the goods, depending upon the proportion of bread.

While this figure is very reasonable, it is not, of course, as low as with natural gas fuel or oil fired stationary ovens.

As there is no combustion, no current of air is necessary, and the baking chamber is practically sealed; this results in less shrinkage (which is especially important in the roasting of meats), and more moisture remains in baked goods so that they last longer before becoming stale.

For maintenance expense probably $5.00 per oven per year would be a high estimate based on those in operation to date. There is very little trouble, other than a terminal bolt needing replacing or the burning out of the heating element. In the latter case, it is only necessary to remove the element and braze the ends together.

(e) Desirability of Load

The prevailing tendency today seems to be the installation of many small bakeries at strategic points in the business districts. As the electric oven is peculiarly adapted for such conditions, there seems to be no reason why this profitable load should not be secured. If a reasonable heating rate is offered and a few ovens are sold in a territory so that the prospects can observe their operation, the electric ovens possess so many advantages that they will practically sell themselves.

The electric oven, even with a heating rate of 3 cents per kw-hr., is a good revenue producer. The ordinary portable size will yield about $50.00 per year per kilowatt of maximum demand.

As the usual installation is located in the business district, and the load is "off peak," there is little expenditure necessary for lines or transformers. The load has almost unity power factor and no large starting currents are required.

Enameling Ovens

The baking of enamel, or japan, by means of electrical heating is now accomplished very successfully, and many large companies have adopted this method of baking due to its many advantages. Many small installations are operated very satisfactorily. There have been developed a number of types of ovens for this work, depending entirely upon the character and size of the work to be accomplished. Standard types of heating elements are being manufactured, and the oven can be built in any shape or size.

There are certain points to be considered in the installation and the operation of electric enameling ovens, a few of which are as follows:

1. Size of oven
2. Shape of oven
3. Temperature to be maintained
4. Weight of material to be baked
5. How material is to be handled
6. Weight of trucks or carriers
7. Cycle of heat operation
8. Outside temperature of oven
9. Amount of moisture to be removed.

Probably the most important point to be taken into consideration is the weight of the material to be handled and the weight of the carrier. Each kind of material has a certain specific heat, or, in other words, it takes a certain amount of power to raise the mass 1° F. With information as to the weight and specific heat of the material to be treated and the weight of the carrier, the power to do the work in a certain time may be estimated provided the final and initial temperatures are known.

The radiation losses on the oven are dependent on the size, shape, thickness and kind of material of which the oven is made.

Miscellaneous Industrial Heating Devices

There are many miscellaneous uses for industrial electrical heating. Dry cleaning establishments now use electric heat on account of the poor quality of gasoline to dry the odor from the clothes. An installation of an electric heater, of from four to ten kw. in capacity, does this work very satisfactorily, eliminating all danger from fire and explosions.

Lumber companies use electric heaters for heating and drying lumber and for glueing. Organ manufacturers use electric heating for the same purposes. Cleanness and freedom from fire hazard are the two main advantages.

Rivet heaters are now being manufactured and give satisfactory use, having the following advantages over other types:

Rivets being heated from the center, give better uniformity of heat, less wastage, high efficiency by localizing the heat, and close heat regulation, and power is used only while rivet is heated. This machine requires about 15 kw. to operate two jaws.

There can now be secured from the manufacturer many standard appliances to be used in industrial heating, such as standard heating units, glue pots, compound melting pots, oil tempering baths, rivet heaters, solder pots, muffle furnaces, bake ovens, brooders, incubators, and any number of other appliances.

Appendixes "A," "B," "C" and "D" which follow describe a few typical installations of low temperature industrial heating.

HIGH TEMPERATURE INDUSTRIAL HEATING

In preparing a paper on the subject of high temperature industrial heating, we have of intent omitted the subject of the melting of brass, as this subject was thoroughly covered at the last convention of this society.

Electric Furnaces for Steel Making

Types

In earlier years on the Pacific Coast, many desultory attempts were made to make steel castings, but with very uncertain results, the chemistry and heat treatment being comparatively unknown to the men in charge of operation. It was not until about 1904 that any continuous success was made in this industry. At that time the converter process was adopted, and after many trials a very satisfactory product was made. This, however, was what is called acid process, that is the furnaces were lined with silica, and as a consequence, more reduction of the detrimental properties was accomplished. Later, the open hearth furnace was introduced, and this was operated mostly basic, which permitted of the reduction of sulphur and phosphorus by slagging.

Still later came the introduction of the electric furnace, both basic and acid lined, the former however, giving the most efficient service and producing the best material. The principal features of advantage of the electric furnace are these refining qualities. By reason of the absolute temperature control, a heat may be held in the furnace and slagged once, twice or more times as desired, to give the exact analysis required. Alloys too can be added, and a very uniform distribution of the alloys throughout the material can be accomplished.

There are three or four well known makes of electric furnaces and scores of others which are not as well known, but of which there are a few installations in the United States. All of these different furnaces are for the production of steel, although of more recent date a different form of electric furnace has been used very successfully for heat treatment of steels, annealing, tempering, soaking, etc. In contemplating an installation, many factors would have to be considered before deciding which furnace would be most favorable for the production of a certain grade of work.

Sizes

Electric furnaces for the production of steel are made in sizes up to forty tons, a forty-ton furnace having recently been started at the Charleston Navy Yard. On the Pacific Coast, the largest furnace is of six ton capacity.

Furnaces with capacites of over six tons are generally used for the refining of hot metal. This hot metal is taken direct from the open hearth furnace or Bessemer converter and charged into the electric furnace for refining. These large furnaces are not built at this time for the handling of cold scrap charges.

Operation

The heat from melting the charge in an electric furnace is produced by an electric arc which is formed between the electrode and the scrap or metal. There may be two or more electrodes, depending upon the size and style of furnace.

When a heat is started in an electric furnace, the arc produced between the electrode and the charge melts the scrap directly underneath the electrode, until a small pool of molten metal is formed, on the bottom. During this time, the electrode works down through the scrap, and as soon as a pool is formed the arc becomes steady and is buried in the scrap. The radiation from this arc rapidly melts the balance of the scrap. The melting is really from the bottom, and if the furnace is operated correctly, there is very little chance of skulls being left on the bottom.

Control

The power used in melting may be controlled by automatic regulators which can be set to obtain a desired current. Most of these regulators automatically raise or lower the electrodes, thereby keeping the power load constant. Another type maintains approximately constant current by varying the voltage applied to the electrodes. During the melt-down, there tend to be numerous surges of power, due to momentary short circuits between the scrap charge and the electrodes. A good automatic control will reduce these to a minimum. The temperature of the metal can be easily controlled by the power input, and steel of any temperature can be made, especially very hot steel for the pouring of small castings.

Costs

The cost of power per ton of product varies according to the amount of energy used, and the grade of steel produced. The cost of electric furnace steel as compared with Open Hearth or Bessemer steel depends upon a great many conditions. An electric furnace installed in one plant might produce steel more cheaply, whereas if installed in another plant might produce steel at a higher cost, as compared to the process already in operation.

Electric steel can be produced at a much lower cost than crucible steel, quality being equal. Certain alloy steels can be made a great deal cheaper in the electric furnace than in the Open Hearth furnace.

Electric steel is more uniform as to quality than steel produced in the Open Hearth. This is in part due to the reducing and non-oxidizing atmosphere within the electric furnace, and the ease with which a refining slag can be made.

The melting loss in a crucible furnace runs from three to five per cent, whereas in the electric furnace, the loss is usually only one or two per cent. The reason for this reduced loss is the non-oxidizing atmosphere in the electric furnace. These savings range from $6.00 to $20.00 per ton in the cost of the material and labor. In addition to this saving, freedom from smoke, heat and gases in the foundry are great advantages which cannot be measured in dollars. A further saving is the fact that the material produced is, by reason of its being produced in a non-oxidizing furnace, of a much higher grade, free from porosity, with a consequent reduction in the percentage of rejected castings.

Supervision

The human element probably enters more into the making of good electric steel, than into any of the other processes, because in most cases the electric furnace is used for the production of special alloy steel, or high grade castings.

Experienced men are required to get good results, but men may be trained to operate electric furnaces successfully more readily than the same class of labor can be taught to get equivalent results with Open Hearth or Bessemer furnaces.

Appendices "F" and "G" of this paper give descriptions of two interesting installations of high temperature industrial heating.

Appendix "A"

THE ELECTRICAL PRESERVATION OF EGGS

New and Unique Applications of Electricity for Industrial Heating Purposes

A process of preserving eggs which keeps them fresh and eliminates evaporation and losses has recently been accomplished by electrical energy. The egg is put in such condition that it may be left in the open air for weeks without spoiling, and also the shrinkage while in storage is eliminated. This process consists of dipping eggs in an oil bath heated to 260° F. for 7.5 seconds. The oil used is a clear odorless and

(Continued on page 517)

Evaporation From Reservoirs

BY H. A. BARRE

(The storage of water for hydroelectric development presents various problems to engineers, among them the question of evaporation and its relation to the available supply. Though exact data on this subject is exceedingly difficult to obtain, the combined papers presented to the Pacific Coast Section N. E. L. A. by the sub-committee for collection of data on evaporation, are an authoritative contribution to the study of this important problem.—The Editor.)

Inasmuch as the quantity of storage water lost annually through evaporation is an important factor in computations made to determine the amount of water available for hydroelectric power, a study of methods for ascertaining this loss is appropriate.

In the several technical papers attached, generously submitted by our California authorities Messrs. C. E. Grunsky, Engineer, N. W. Cummings, Meteorologist Scripps Laboratory, and Chas. H. Lee, State Water Commission, the theoretical problem is ably outlined. We also note the difficulties in establishing data and the many variables which enter into the calculations. However, a number of formulas have been established for use until further study and research develop better.

A point emphasized by Mr. Cummings is that during the early season a portion of the heat available for evaporation is absorbed in warming the lower layers of water and in turn is given off later in the season when the entire body starts cooling. This no doubt retards the evaporation in the early season and increases it toward the end. Therefore, the manner in which the storage water is used by hydroelectric companies where the bottom water is drawn off will cause an earlier equilibrium of temperature and increase the evaporation, but later in the year there will not be so much release of heat and evaporation will be relatively subnormal.

Mr. Grunsky emphasizes the effect of altitude and mean temperature on the rate of evaporation, and presents curves for determining evaporation from mean temperature records and a table for latitude correction.

Mr. Lee's paper treats the subject from the standpoint of the hydraulic engineer, and lists the important precautions which should be observed in collecting data on evaporation.

We note on page 126 of the treatise on Hydrology by Daniel W. Mead, published in 1919, the following statement:

"While evaporation varies from year to year in accordance with the variation in controlling factors, yet this variation is apparently much less than the variation in most other meteorological phenomena, such as rainfall, temperature, etc."

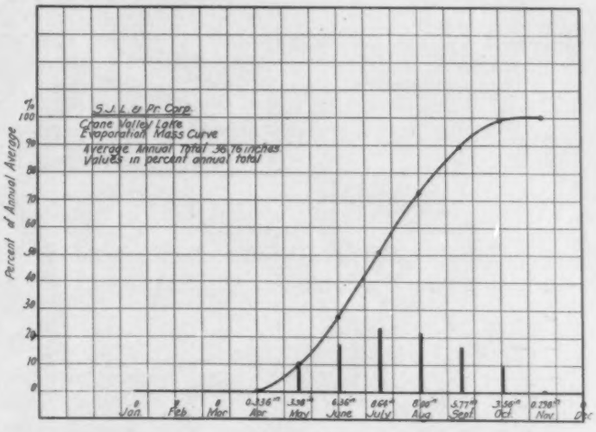
The measurements conducted by the San Joaquin Light & Power Corporation by the floating pan method at their Crane Valley Lake, show evaporation negligible for the winter months. On the other hand the Weather Bureau records for the Arizona and California stations show evaporation for the entire year which is undoubtedly more scientifically correct. The mass curves of the annual evaporation for the several locations, however, show that by far the greatest per cent loss occurs from May to November each year.

Drawing water from the lower layers would also, as explained above, introduce further complications. However, we note that the various authorities while stating that the subject requires a great amount of further study, investigation and experiment, admit that the floating pan method of determining evaporation, if carefully conducted, gives a very fair approximation of the correct results.

It is well to note also that these records obtained for various sections of the country, while they may not be valuable for the computing of formulas, are quantitatively correct, and automatically include many of the variables, such as wind movements, mean temperatures, humidity, etc., and require only the altitude correction.

The problem confronting the operating engineers connected with the hydro-electric companies is that of predicting the probable annual loss from evaporation which will be suffered during the year under consideration, usually the year immediately in the future.

In predicting it is necessary to confine one's self to averages as to precipitation, run off, evaporation, etc. It would seem apparent therefore that it would be logical to use the



Measurements taken by the San Joaquin Light & Power Corporation at Crane Valley Lake, elevation 3500 ft., show evaporation almost negligible during the winter months.

average annual depth of evaporation as determined for various locations with similar exposures, etc., for any individual reservoir under consideration. For example, the record by the floating pan method, kept by the San Joaquin Light and Power Corporation at Crane Valley Lake (elevation 3500 ft.) for a period of nine consecutive years, establishes an average annual evaporation depth of 36.76 inches, and it appears reasonable to approximate the annual evaporation loss at the Southern California Edison Company's Huntington Lake by applying this figure, preferably by the use of the monthly values applied to the average area of the lake for the month, making allowances for altitude.

In the same manner data available in the southern and northern parts of the state could be used for lakes in the respective locations, which should give results within reason for all practical purposes.

From the tabulation of the Weather Bureau 1920 evaporation records by atmospheric pan method from four Arizona stations furnished by Mr. R. Q. Grant, we note that the annual evaporation for the four stations is 79.64 inches and that the greatest departure from average is 12% at Yuma. Furthermore, it is probable that this station is not comparable with the other three which show very close annual tables.

The average of the Weather Bureau records for the several California stations is not computed as the stations are widely separated and vary much in elevation. Atmos-

pheric pan for the first three and floating pan for Tahoe. The annual totals are as follows:

Location	Elevation	Annual Evaporation
Chula Vista, near San Diego.....	9	63.60 Av. 2 yrs.
Dodgeland, Sacramento Valley ..	125	66.455 Av. 2 yrs.
Oakdale, San Joaquin Valley	215	84.569 Av. 2 yrs.
Tahoe.....	6230	37.30 plus Av. 4 yrs.

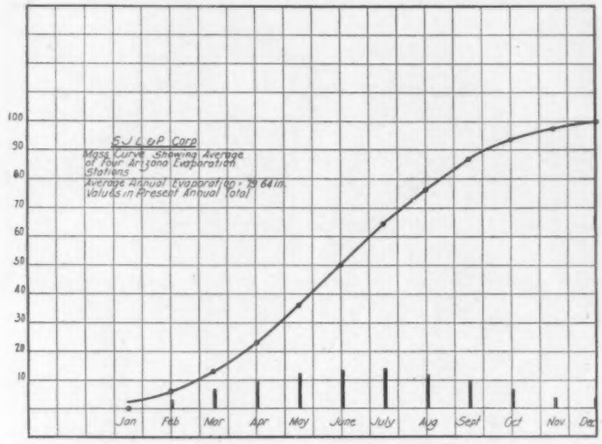
Data secured by Mr. R. J. C. Wood of the Southern California Edison Company, through the courtesy of Mr. Hedges, civil engineer of the Arrowhead Reservoir Company, shows approximately 36.29 inches annual evaporation at Little Bear Lake, elevation 5160 ft.

From the records submitted by Mr. P. O. Crawford for Klamath Lake, the evaporation loss is 53.42 inches.

The following tabulation compares the annual evaporation recorded for several mountain locations and it is interesting to note that these totals show only small variation in spite of the difference in elevation, wide geographical separation and varying exposures:

Location	Elevation	Annual Evaporation
Crane Valley Lake	3500	36.76 Av. 9 yrs.
Little Bear Lake	5160	35.76 Av. 9 yrs.
Lake Tahoe	6230	37.30 Av. 4 yrs.

From the previous tabulation showing the California stations, the almost identical annual figure obtained for Chula Vista and Dodgeland is probably explained in that excessive



Mass curves show the average annual evaporation at four Arizona stations as 79.64 inches, the greatest per cent loss occurring from May to November.

wind movement at the first place is balanced by increased temperature at the second. The record of 82.13 inches annual total at Oakdale is from a point surrounded by low foothills in the San Joaquin Valley where temperatures and conditions probably compare favorably with locations in Arizona where the annual totals range from 70.38 to 84.59 inches.

From the brief analysis of the subject it appears that by using a figure for annual evaporation depth determined for a locality by the floating pan method and applying these monthly figures to the average monthly area of the lake under consideration, the evaporation loss obtained will be correct within satisfactory percentages and in keeping with the degree of accuracy of the accompanying predictions as to precipitation and run-off.

In presenting this summary the committee desires fully to acknowledge their indebtedness to Messrs. C. E. Grunsky, Chas. H. Lee and N. W. Cummings, for the valuable papers contributed on this subject, and to Messrs. H. D. McGlashan, A. H. Palmer and R. Q. Grant, for data furnished and for other valuable assistance.

EVAPORATION FROM THE STANDPOINT OF THE HYDRAULIC ENGINEER

BY CHARLES H. LEE

The subject of evaporation is constantly becoming one of greater practical interest to hydraulic engineers. When irrigation and power development depended upon natural stream flow alone, it was purely an academic conception to the engineer; but with the advent of larger projects and the necessity of utilizing flood run-off, the losses from reservoir surfaces became of great importance. In the extreme southwest such losses may amount to as much as fifty per cent of the catchment of a reservoir, and are large even at high elevations in the Sierra Nevada Mountains. Almost every engineer of today who is responsible for the design or operation of a hydraulic system is confronted with the question of what to allow for evaporation losses.

Variation in Experimental Conditions

A search for information yields little of value. The physical theory is still largely in the realm of hypothesis, and the available records are few and apparently yield conflicting results. Wide differences exist in the conditions and methods of measurement with corresponding variation in results. The engineer usually adopts the "floating pan" method, and the agriculturist the "land pan," while the U. S. Weather Bureau follows neither plan but places its pans above the surface of the soil and surrounded by air. The results obtained under otherwise similar conditions by these three methods are widely at variance. The writer's observations in Owens Valley, California, extending over two years, indicated that a shallow land pan record exceeded that from a floating pan by approximately 33 per cent. This value has been confirmed and in some instances exceeded by comparative observations in other localities. Air pans show an even greater excess over that from land pans. Obviously, therefore, no intelligent generalization can be made by the promiscuous use of published records unless the conditions are known under which the data was obtained.

For pans of equal size the most important single factor affecting the rate of evaporation is temperature, both of the water surface and the atmosphere in contact therewith. Factors of minor importance are wind movement and humidity. Considering evaporating pans of differing size, however, from those a foot or two in diameter up to the size of a reservoir or lake, the larger pan has the smaller rate of loss, other things being equal. This is due to the relatively smaller area for escape of vapor in the case of a larger pan, the perimeter increasing directly as the diameter, while the area of water surface increases as the square of the distance. The vapor blanket over a small circular pan has more nearly the shape of the segment of a sphere while that over a lake is for all practical purposes of uniform thickness.

In the case of a small pan floating on the surface of a reservoir or lake, however, it is covered by the vapor blanket of the lake and does not have a distinctive vapor blanket of its own, as is the case for a land or air pan. The size of a floating pan should thus apparently have no effect upon the rate of evaporation therefrom, and the possibility of the measured rate of evaporation from such a pan differing from that of the surrounding lake surface would apparently be limited to the possibility of difference of temperature of the water surface inside and outside the pan. Observations made by the writer and others indicate that such differences are usually very small and it is probable that, considering the relative accuracy of other quantities involved in hydraulic computations, they are negligible.

Method of Collecting Data

It is believed by the writer that for the purposes of the hydraulic engineer, floating pan evaporation observations,

if properly made, are the most reliable and accurate for reservoir calculations. Some of the precautions which should be observed in obtaining such a record are the following:

1. The pan should have a surface area of at least 9 square feet and a depth of about 12 inches, in order that the depth of water may be maintained at about 10 inches. The bottom should be rigidly braced to eliminate the possibility of vertical deflection. A method of accurate measurement at intervals of 24 hours should be provided, a common one being to place a ten-inch pointed copper pin, vertically at the center of the pan, the water surface being brought up to the level of the point at each observation by adding water with a cup, whose volume is equivalent to a 0.01 inch depth in the pan.
2. The pan should be fully protected from splash by means of a raft or other device.
3. The water level in the pan should be at approximately the same level as that surrounding it, and no dark objects, such as leaves or mud, should be allowed to accumulate in the pan.
4. The pan should be located in deep water and at a sufficient distance from vertical faces, such as a dam or steep banks, to insure normal wind and humidity conditions.

In connection with evaporation observations, a record of precipitation should also be kept at a nearby point in order that the pan record, which gives net depth evaporation, may be corrected to obtain gross depth. The correction is made as follows:

When precipitation has occurred between the two readings of the pan, but not in sufficient quantity to raise the water surface above the final level at the previous reading, the total observed depth of precipitation should be added to the observed net depth of evaporation to obtain gross depth. When the precipitation is sufficiently large to have raised the water surface above the final level at the previous reading, the amount of the rise should be observed and subtracted from the depth of observed precipitation to obtain gross evaporation. Gross depth of evaporation is a value more nearly comparable with similar observations at other points with differing precipitation, than is net evaporation. On the western slope of the Sierra Nevada Mountains, or at points on opposite sides of the range, wide differences in precipitation occur within short horizontal distances. The importance of correcting an evaporation record so as to include water lost from precipitation caught in the pan, is obvious. This is especially so if such records are to be used for determining probable evaporation at points for which no evaporation records exist.

Need for More Complete Records

The great need at the present time is for more complete and reliable records of evaporation. Such records should be obtained in the different distinctive climatic zones in order to be of greatest value. From the standpoint of hydroelectric power development, such zones might include high and intermediate levels of the western slope of the Sierra Nevada Mountains in the drainages tributary to both the Sacramento and San Joaquin rivers; the high level of the eastern slope of the Sierra Nevadas both south and north of Lake Tahoe; the valley and plateau regions of northeast rn California, and southeastern Oregon; the upper levels of the Coast Range of San Francisco; and the high levels of certain important ranges of mountains in southern California.

The preparation of a definite program, outlining a standard method of measurement of evaporation and indicating the localities where records should be obtained in the future to be of greatest benefit to the industry, and to the development of communities, is a work which might well be undertaken at this time by some authoritative and active organization.

EVAPORATION FROM RESERVOIRS

BY C. E. GRUNSKY

When the engineer wants to know what allowance to make for the loss of water by evaporation from a reservoir which he has in contemplation, he is generally embarrassed by the lack of data on which to base conclusions. He turns in vain to the law of evaporation or to the formulæ which have been devised and recommended for determining from water surface temperature and atmospheric conditions the momentary rate and he tries to find something definite relating to actual loss from water bodies similar to that which he has in mind, under similar climatic conditions. He may find data that he can use, more likely he will find nothing that is at all dependable. He will turn then to experiments and will endeavor to ascertain the rate at which water is lost by evaporation from a pan. If there is any nearby water body he will float the pan in the water as a pan floating in the water will more nearly approximate conditions as they will obtain on the open water, than a pan placed on the ground. The record of the evaporation from a pan will then be taken to give a fair idea of the relative rate of evaporation at different times of the day and for the various months of the year. Then, according to whether the evaporation was measured from a pan floating in water, from a pan on the ground or from a pan imbedded in the ground, some correction factor will be applied to approximate the rate of evaporation from the proposed open water surface. This method of procedure can not be adopted unless the engineer has time at his disposal—a year or more—and even then he will remain in doubt as to whether he has selected a proper correction factor. Generally the time for experimental determination is not at the engineer's disposal and he must endeavor to estimate the evaporation loss from weather conditions which are generally well known for all parts of the country. How to establish a relation between them and the rate of evaporation from an open body of water is the question.

Note.—Mr. Grunsky's paper was published in full in Journal of Electricity, Jan. 1, 1921, and will not be reproduced here.

EVAPORATION FROM WATER SURFACES

BY N. W. CUMMINGS

THEORETICAL PART

Every one is aware of the existence of an intimate relation between heat and evaporation, but when we attempt to draw definite and quantitative conclusions concerning the nature of this relation, we find ourselves dealing with a complex and difficult, not to say, elusive problem. For example, any one who has been on a duck-hunting trip without being properly clad, knows that, when the experience is over, his clothes dry faster if he puts them near a fire than if he leaves them in a cold place. In this case, high temperatures seem to be associated with high evaporation rates. If on the other hand, one places a drop of ether on the back of the hand, one experiences a feeling of cold, and if one blows on the moistened spot, the feeling of cold becomes more intense, and evaporation is greatly accelerated. In this case, rapid evaporation seems to be associated with low temperature. The observation that clothes dry rapidly in the presence of a high temperature seems on the surface to be incompatible with the observation that the faster you make the other evaporation the colder your hand feels. In other words, an increase in evaporation rate can accompany either an increase or a decrease in temperature, according to other conditions. It is absolutely impossible to obtain a proper understanding of the phenomena of evaporation from reservoirs unless this fact is kept constantly in mind. If we view all the phenomena observed from the standpoint of the first law of thermodynamics, the apparent inconsistency above noted vanishes completely. This conception also helps us to understand much that goes on in a reservoir.

Solar Energy in Evaporation

We shall not depart far from the truth if we say that when the ice on the surface of a lake has just finished melting, the water throughout the lake has a uniform temperature of 4 degrees C. or 39 degrees F. Let us suppose this condition to exist at the middle of March. In the case of fresh water lakes, which are situated in a climate like that of southern

California, and which therefore do not freeze, the temperature at this time of year may be a little higher, but not much. For the time being let us ignore this difference. If we deal with averages we may say that at this time of year, the sun and sky are causing a certain definite quantity of energy to fall on the surface of the lakes each day. At Madison, Wisconsin, according to Eric R. Miller (1920), this quantity is 342 gram calories per square centimeter, assuming that the daily value at the middle is equal to the average for the whole month. For the present purpose, which is merely that of illustration, it is not so important to specify the exact magnitudes as to emphasize the fact that as climatological data go, they are relatively definite.

Now this definite amount of energy received each day can do a certain amount of work. If a certain part of it is used in warming the water, then that same part cannot be used again in evaporation of water. Any evaporation that occurs must be done by virtue of the remaining part of the energy. This amounts to a statement of the first law of thermodynamics. But so far as this law is concerned, the total solar energy can divide itself in an infinite variety of ways, between warming the water, evaporating the water, being reflected from the surface, and being radiated back toward the sky as the characteristic radiation of the water body. The particular manner in which the radiation actually does divide itself between the first two methods of disposal (warming and evaporating) is, in all probability, dependent on the temperature, humidity and movement of the air, but the total amount of energy available for such distribution is entirely independent of temperature, humidity and movement of the air, except as transparency may be thus affected. It seems fair to say, therefore, that relatively, too much attention has been paid to the so-called evaporation power of the air, which is supposed to depend on these things. The evaporating power of the sun and of the water seem not to have been sufficiently heeded.

Seasonal Changes in Temperature

Returning now to our lake of nearly uniform temperature throughout, it is evident that if the season did not advance, or in other words, if insolation did not increase beyond what it is during the middle of March, the lake would, after warming slightly, especially in the upper layers, reach an equilibrium temperature, at which evaporation would exactly balance insolation. Yet such a condition is not actually reached until late summer, because while the lake is approaching that temperature which at any given instant would bring about equilibrium, the equilibrium temperature is itself rising on account of the increase in insolation. In late summer, however, after the insolation has passed its maximum and is decreasing, there must be a short period during which the equilibrium condition can and does exist. This deduction is in accord with observation. During late summer, the heat content of the lake is found to change very little. This is, of course, the time of maximum temperature.

During the spring and early summer, the lake is warming up—the upper layers faster than the lower ones—and during late summer and fall, it is cooling off. In southern California there is a late winter minimum corresponding to the late summer maximum, but in a lake that freezes, this phenomena is complicated by the formation of the ice. If, for simplicity, we ignore, temporarily, that part of the sun and sky radiation which is reflected from the water surface and also that part which is returned as characteristic radiation of the water, we can draw certain general conclusions regarding the manner of division of the remaining part of the energy between heating the water and evaporating it.

When the lake is warming up, there is not so large a proportion of the energy available for evaporating as at other times of the year. Thus if we choose one day in spring and another in the fall, such that the insolation is exactly the same on the two days, the evaporation will in general be greater on the latter one, because at the time the total energy available for evaporation is equal to the insolation **plus** the quantity of heat given up by the lake in cooling, while in the spring it is the insolation **minus** the quantity of heat absorbed by the lake in warming.

Practical Application

(1) The most economical way to use impounded water.

(2) The best way to interpret the observations of a floating pan.

Much might be said concerning the first point, but in this paper space will not permit more than two simple suggestions:

(a) From the standpoint of evaporation losses, water should be taken from the top of the reservoir since there is usually a large temperature gradient beginning at a depth of from 10 to 15 feet, so that if the water is drawn from the surface, evaporation is delayed to the extent of warming up the bottom layers.

(b) So far as evaporation losses alone are concerned, as much water as possible should be used before a certain time in late summer because evaporation does not reach its maximum until this time. The exact point in the yearly cycle at which the maximum evaporation occurs, and the saving in water that can be effected by distributing the use with respect to it cannot be determined without making extensive observations of radiation and temperature at various depths, but it is certain that the time is about the first of August.

The second point, which is the proper method of interpreting the results of floating pan measurements, has received much attention. At this time it is difficult to say with respect to this, more than that during the warming-up period, the lake probably keeps the pan relatively cool, thus retarding evaporation somewhat, but during the cooling off period, the lake tends to keep the pan relatively warm, thus accelerating evaporation. We have not yet investigated these assumed effects quantitatively, except for the observations made at Lake San Dieguito. This work will be described more fully in the second part of this paper, but it may here be said that during the late summer and early fall, a floating pan gave a greater depth of evaporation than a nearby ground pan, but as winter approached, the difference tended to vanish. This is, of course, consistent with our assumption and we expect that in the spring the ground pan will give the greater value.

Relation Between Evaporation and Temperature

Concerning the much talked of relation between evaporation and temperature (either water or air) a few general principles may be noted. It must be remembered that high evaporation rates can be associated with either high or low temperatures, so that from this fact alone, it might seem that we should expect no correlation between evaporation rates and temperatures. If, for example, two lakes, A and B, receive equal amounts of radiant energy during a given time interval, but at the end of the interval B has a lower temperature than A, then we must conclude that evaporation has been non-active at B, the colder lake. If we look for a cause (as distinguished from evidence) we must conclude that the humidity has been lower or the wind higher at B than at A. If, on the other hand, A received much more radiation than B, then B will be colder and its evaporation be lower. If, therefore, we have no data except water temperatures, and if at the same time we admit the possibility of wide differences in amounts of radiation received by different lakes, and wide differences in humidity and wind conditions, then the relation between water temperature and evaporation rate is entirely indeterminate. Under these conditions, knowing one cannot be of any use whatever in finding the other, even if comparative results are all that happen to be desired. If, however, the amount of radiant energy is the same for all lakes, or if

wind and humidity conditions are the same, then the problem becomes at least determinate enough to enable one to obtain comparative results. Which of these assumptions more nearly approaches actual conditions is an open question.

If statistics have been found to give any correlation between water temperature and evaporation, one of two conditions must exist with respect to the lakes for which the statistics apply:

(1) The correlation may be negative. In this case, the radiation is approximately the same for all the lakes, but wind and humidity conditions vary, thus causing some lakes to lose water and therefore cool faster than others.

(2) The correlation may be positive. In this case, the resultant effect of wind and humidity conditions may be constant, but the radiation varies (owing to differences in atmospheric conditions, altitudes or sun's declination), and hence some lakes receive more heat than others. A part of the excess which some receive over others may be spent in warming the water and the rest in evaporating a part of it.

If statistics are taken from lakes chosen at random, then both of the above sets of conditions would probably exist in the group, and we should have both a positive and a negative correlation existing simultaneously, which of course would mean not much of any correlation at all.

So far as the writer is aware, there are, unfortunately, only a very few measurements of evaporation which have been made directly on the lake itself. Consequently, at the present time no correlation can be run to check the validity of the above reasoning without substituting pan measurements for actual evaporation from lakes. This is hardly a satisfactory substitution since the relation between pan and lake results is itself open to question. Correlations have been run, however, between pan temperatures and pan evaporations, and the coefficient always turns out to be positive. (See Duryea and Hachl, 1916.) The probable error is always large, however, which accords with the assumption made here.

The first step in the attack on the evaporation problem which the writer and Dr. McEwen propose to make is to work out a method of determining with a reasonable degree of certainty just how much water leaves the surface of a lake by evaporation during any given time interval. If this attempt is successful, then an effort will be made to correlate the results so obtained with latitude, altitude, humidity, wind, temperature and any other variables that may be advisable. But before any of those correlations can be run with satisfactory results, it must be possible to determine just how much water evaporates from any particular lake during any given time interval.

It seems reasonably probable that a positive correlation will be obtained between evaporation and air temperature, because air temperature tends to increase with soil temperature which in turn tends to increase with solar radiation, so that air temperature is a rough measure of radiation.

OBSERVATIONAL PART

The proposed method of determining the actual evaporation from a lake during any interval of time consists of the following steps:

(1) Determine for the interval the excess of solar and sky radiation penetrating the water surface, over that which the water emits toward the sky as characteristic radiation.

(2) Determine also for the same interval the change in heat content of the lake, taking proper account of any gain or loss due to heat entering or leaving with a flow of water into or out of the lake.

(3) Find the algebraic sum of the heat change and the radiation, and divide this sum by the heat of vaporization of water to obtain the true evaporation.

This method is certainly sound as far as its elementary theory is concerned, and it is hoped that the practical experimental difficulties will not be entirely insurmountable.

Apparatus for Measuring Solar Radiation

Much work has been done for the purpose of determining the quantity of solar radiation falling on a given surface; but as far as the writer is aware, this has all been directed either (a) toward finding the solar constant, which is the amount received at the other limit of the earth's atmosphere, or (b) toward finding the amount that reaches the earth's surface. Neither one of these quantities is exactly what is needed for the present purpose, although both of them may be used in connection with this work. What is desired is the amount of energy that penetrates the water surface, or more strictly, the excess of this over the amount that is radiated back. This quantity might be calculated by correcting the total energy received at the earth's surface for the amount reflected and the characteristic radiation of a body at that temperature, as deducted from optical principles. The advantage of this procedure would be to utilize solar radiation measurements that have been made in the past and are still being made at various stations. The difficulty, however, of making proper corrections is at present an unknown quantity. However, the apparatus ordinarily used for solar radiation measurements is rather expensive.

The method that Dr. McEwen and the writer have planned to use requires apparatus of a very inexpensive nature. We expect to procure a vacuum insulated vessel of about 10 cm. diameter and a similar depth, blacken the inside, fill with water, and observe the depth of evaporation. The small mass of water will make the change of heat content almost negligible in comparison with evaporation, but if it is not entirely negligible it can easily be determined. Moreover, the vacuum insulation together with the blackened surface, will insure that practically all the radiation with which we are concerned, shall be consumed either in evaporating a part of the water or raising its temperature. A certain amount may be lost by conduction and radiation through the surface, but this will certainly be small and probably about the same for the insulated vessel as for the lake. It is hoped, therefore, that this simple device will meet our needs, but as yet it has not been put into operation. This will be done as soon as a vessel can be procured.

The measurement of the heat change introduces no particular difficulties if the contour of the lake bottom is known. We have found that at Lake San Dieguito, observations in the early morning at the position of greatest depth can with little error be assumed as representative of all other positions on the lake. The reversing thermometer has been used. For a time, the temperature of the intake water was not measured, so that an unknown change in heat content occurred on

EVAPORATION TABLE — SAN DIEGUITO RESERVOIR

Lake Surface		Ground Pan Inches Evap.	Ground Pan Temp.	Floating Pan Inches Evap.	Floating Pan Temp.	Lake Surface Temperature
June	9			1.6	75.8	76.5
	16			2.0	74.6	73.7
	23			1.8	77.8	76.7
	30			2.1	76.5	75.0
July	7			1.9	76.5	77.0
	14			2.1	77.7	77.5
	21			1.9	81.0	79.5
	28			1.8	80.0	79.3
Aug.	4			1.7	83.5	82.8
	11			1.81	81.50	81.0
	18			1.70	79.0	80.2
	25			1.75	75.5	76.3
Sept.	1	1.39	74.7	1.48	76.4	76.6
	8	1.53	68.4	1.61	72.7	74.0
	15	1.27	72.9	1.35	74.7	74.5
	22	1.32	67.1	1.35	71.0	71.3
	29	1.15	69.1	1.25	71.8	71.8
Oct.	6	1.03	72.5	1.12	71.9	71.8
	13	1.10	72.5	1.22	69.6	69.8
	20	1.03	56.9	1.37	.65 2	65.7
	27	.87	58.6	1.02	63.7	64.4
Nov.	3	.57	59.0	.53	62.5	62.0
	10	.51	58.8	.44	61.0	60.8
	17	.50	61.70	.49.	63.8	62.6
	24	.50	56.2	.56	59.9	60.3
Dec.	11	.85	56.2	Pan filled by waves	59.5	58.0

that account, but it is hoped that in the future this difficulty will be obviated.

There is on the premises of this institution a large concrete lined tank six and one-half feet long, five and one-half feet wide, and six feet deep. We expect to use this for a campaign of intensive evaporation study, applying all possible methods and comparing results.

Data From Weekly Observations

Since September 1, we have been making weekly observations of both ground pan and a floating pan at the San Dieguito Reservoir, which is controlled by Ed. Fletcher Co. The pans were installed by this company. The results of the observations are shown in the accompanying table.

All readings were made between 8 a. m. and 10 a. m. Each temperature entered in the table was observed by placing the bulb of the thermometer just below the water surface. It was found that the temperature was usually not uniform throughout either pan.

Literature Cited

1920 Miller, Eric R.
Measurements of Solar Radiation at Madison, Wisconsin, with the Callendar Pyrheliometer. Monthly Weather Review vol. 48, pp. 330-343, 4 curves, 7 tables in text.

1916 Duryea, Edwin Jr. and Haehl, H. L.
A Study of the Depth of Annual Evaporation from Lake Conchos, Mexico, Trans. Am. Soc. Civ. Engineers, vol. LXXX pp. 1829-2060. Plates LXII to LXIX, Tables 1 to 99, figs. 1 to 31.

EVAPORATION PROBLEM

The importance of a thorough knowledge of the physical and chemical conditions of the sea to a proper study of marine biology was formerly recognized by the scientific conference of the Pan-Pacific Union, held in Honolulu in August 1920. The point has also been discussed by many students of the life of the sea, including E. L. Michael (1916) and William A. Herdman (1920). One of the most important of all the physical features of the sea is its temperature distribution, and this in turn is known to be closely related to the rate of evaporation of the surface water. It follows, therefore, that a study of evaporation from the ocean surface is one of the most important elements that must be included in a proper study of marine biology.

Evaporation from the Ocean

But a direct study of evaporation from the ocean is obviously impossible and consequently indirect methods must be resorted to. A primitive method but nevertheless one which has been and is still extensively employed for determining evaporation from large water surfaces, both ocean and lake, is to make use of a pan, or as it may in some cases be called, a small tank. The pan is filled with water and subjected to conditions that stimulate those of the large water surface as nearly as possible and the depth of evaporation during short intervals of time is measured. This device is known to have been used as early as 1722. Its disadvantage is that no pan or small tank can ever be made to simulate a large body of water exactly and the effect of the unavoidable differences in any particular case cannot be accurately estimated. Pan results, therefore, give us very little positive knowledge about evaporation depths from large water surfaces unless they are supplemented by other information.

It was suggested by Dr. McEwen that conditions in lakes and reservoirs might simulate those in the ocean closely enough to make an investigation of their temperature and evaporation worth while from the point of view of oceanography. At the same time the difficulties presented by lakes seemed not to be entirely insurmountable. It was accordingly decided to use available lakes and reservoirs as laboratory apparatus, so to speak, for the study of the thermal phenomena of the ocean. The direct economic benefit of such a study is by no means insignificant. The subject of evaporation from lakes and reservoirs has received a great deal of attention from eminent engineers.

At the present time the standard evaporation pan mostly used by engineers is three feet square and eighteen inches deep, although the Weather Bureau uses circular pans four feet in diameter and ten inches deep. Many attempts (including those of Duryea and Haehl, 1916) have been made, to obtain a relation between pan results and actual evaporation from lake surfaces, but there is still much difference of opinion.

Investigation Under Way

Dr. McEwen is now working on a theoretical study of thermal phenomena in large bodies of water and expects that an estimate of the rate of evaporation under various conditions will be among his conclusions. He requires extensive data, particularly, temperatures at various depths and times of year, and observations of solar radiation for testing the forms of the functions he deduces and determining their constants. Although much data is now available, there is need of many more simultaneous observations of solar radiation especially in the vicinity of San Diego. There is, in fact an opportunity for a supplementary problem, emphasizing the field or observational side. This is the problem that I have chosen for a thesis. It is not, however, purely observational although that is the main part. In fact, by a rational procedure less fundamental than Dr. McEwen's, I hope, by investigating the main factors controlling evaporation to arrive at an estimate which can be shown to depart very little from the truth. In this investigation I shall make some use of the results of pan observations.

As a check on the other methods, it is hoped that in one or two lakes we may, through cooperation with the engineers of the Ed Fletcher Co., be able to compute the evaporation by the simple relations between inflow, draft and change of depth. This procedure is rendered unsatisfactory in most cases by the uncertainty of inflow and draft data, and in some cases by seepage, but it is hoped that in the lakes referred to, these troubles will be in a large measure eliminated. Another method which we may be able to apply at Lake Elsinore is to estimate evaporation from average depth and change of salinity. It so happens, moreover, that on the premises of this institution is a concrete-lined tank six and one half feet long, five and one half feet wide, and six feet deep, which formerly was used as a pit for the pumps which furnished water for the aquarium. It is our purpose to make this perfectly water tight, or as nearly so as possible and then use it for more extensive evaporation studies. The relatively large dimensions make it highly suitable for this. Some preliminary work already done with it seems to promise fruitful results.

Evaporation Literature

The literature on the subject of evaporation is very extensive. Mrs. Grace Grey Livingston of the Weather Bureau has compiled an annotated bibliography of the subject, beginning with the year 1670. This work is published in the Monthly Weather (Bureau) Review beginning on page 181 of volume 36 for 1908. Mc Ewen (1918 p. 413) quotes Wilhelm Schmidt as giving .0754 meters per month as a good average estimate of evaporation from the ocean surface at the latitude of San Diego. Krummel (1907) gives a table showing the results of evaporation measurements. He agrees substantially with Schmidt, but emphasizes the need of further research. C. H. Lee (1919) discusses the subject of evaporation in San Diego county. He concludes that the rate of loss from a floating pan under favorable conditions of measurement is just about the same as that from the whole lake surface. He states, however, that the subject requires further investigation, a sentiment in which we heartily concur. Perhaps the most comprehensive set of papers relative to this matter thus far assembled in one publication, is the group containing the report of the Lake Conchos investigation

by Duryea and Haehl (1916), in which the problem is attacked from a great variety of view points. In collaboration with Dr. McEwen I have already made some evaporation studies at Lake San Dieguito. Our results seem to indicate that at least during the autumn and late summer a pan in the ground gives a lower depth of evaporation than one floating in the lake. It is still an open question how the evaporation from the lake surface compares with that from the two pans.

Dr. McEwen has received from Dr. E. A. Birge of the University of Wisconsin, a table of average temperatures observed at Lake Mendota. The data presented is based on observations extending over a period of ten years. We have moreover made observations at Lake Elsinore, Lake San Dieguito and Lake Cuyamaca. In all four cases we find that the gradient follows a certain type of curve in a very well defined manner. Dr. McEwen has attempted to predict such a gradient from certain theoretical considerations, including surface evaporation, and has met with considerable success. But he is in great need of further observational data. I expect to do something toward supplying this need, and at the same time to obtain results that can, by other methods of treatment, be made to throw light on the question of evaporation.

Literature Cited

Duryea, Edwin, Jr., and Haehl, H. L.
(1916) A study of the depth of Annual Evaporation from Lake Conchos, Mexico. Trans. Am. Soc. Civ. Engineers, Vol. LXXX, pp. 1829-2060, 31 figs., 91 tables.

Herdman, William A.
(1920) Oceanography and Sea Fisheries (Presidential address delivered at the Cardiff Meeting of the British Association Auguest 24, 1920). Nature, Aug. 26, 1920. V. 105 No. 2652, pp. 813 to 825.

Kadel, Benjamin C.
(1919) Instructions for Installation and Operation of Class "A" Evaporation Stations. Circular L, Instrument Division, U. S. Weather Bureau.

Krummel, Dr. Otto
(1907) Handbuch der Oceanographic. Stuttgart, J. Englhom.

Lee, C. H.
(1919) Geology and Ground Waters of the Western Part of San Diego county by Arthur J. Ellis and Charles H. Lee, Water Supply Paper No. 446, U. S. Geol. Survey.

Livingston, Mrs. Grace Grey
(1908 et seq) An Annotated Bibliography of Evaporation,

Mc Ewen, George F.
(1918) Ocean Temperatures. Their relation to Solar Radiation and Oceanic Circulation. Misc. Studies in Agriculture and Biology, Semicentennial Publ. Univ. of California.

Michael, E. L.
(1916) Dependence of Marine Biology upon Hydrography and Necessity of Quantitative Biological Research.

TABLE OF PRECIPITATION, EVAPORATION, ABSORPTION, ETC., AT THE GATE HOUSE OF THE ARROWHEAD RESERVOIR COMPANY AT LITTLE BEAR VALLEY

Elevation 5160 Ft., Latitude 34° 16′ 10″ North, Longitude 177° 11′ 24″ West of Greenwich.

San Bernardino County, California

Month	Temperature			Precipitation Inches	Evaporation				Absorption Inches of Water Penetrating 3′ of Soil	Wind		
	Maximum	Minimum	Mean		Water Inches	Surface Temperature	Snow Inches of Melted	Surface Hours of Exposure		Total Miles	Maximum Velocity	Prevailing Direction
1895												
March	71	18	42.4	8.82	1.12	38.0	.64	192		4787	24	S.SW
April	77	24	49.1	1.31	1.84	42.0				4207	29	SW
May	86	30	55.4	.24	5.30	58.0			.17	3723	30	SW
June	84	31	62.2	.00	6.60	60.6			.00	3589	35	S
July	88	40	63.8	.00	6.30	67.1			.00	2324	32	S
August	89	38	66.2	Trace	6.20	66.2			.00	3032	27	S
September	83	33	62.2	.00	5.05	58.6			.00	1790	21	S
October	84	32	54.5	.00	2.80	52.6			.00	2120	12	SW
November	69	22	38.8	2.65	1.20	42.0	.05	10	.00	3070	19	SW
December	70	14	38.9	1.75	.34	38.6			.00	2217	23	N
					36.82							
1896												
January	67	22	42.5	2.38	.09	39.0			.00	2848	15	SW
February	68	22	43.4	Trace	.81	43.0			.00	2956	27	N
March	73	15	41.5	4.21	.94	42.0	.55	107	.09	4546	67	S
April	65	23	41.7	1.72	3.39	44.0			.13	6112	38	S
May	81	26	52.1	.47	2.86	59.0			.00	3953	30	SW
June	96.5	36	64.1	.00	6.50	67.0			.00	4727	30	SW
July	90	37	68.3	.00	5.04	67.5			.00	4465	27	SW
August	88	43	66.2	.33	5.50	65.0			.00	4061	25	SW
September	88	32	58.7	.00	4.01	60.0			.00	3683	19	SW
October	74	27	54.3	2.30	4.05	54.0			.00	3470	37	SW
November	68	18	44.0	1.38	1.28	46.0			.00	3950	30	SW
December	69	23	42.3	1.98	1.23	39.0			.00	2619	27	N
					35.76							
1897												
January	57	18	35.2	5.16	.57	36.0	.72	335	.00	4342	39	SW
February	57	5	32.0	12.05	.24	38.0	.61	144	.34	3422	41	N.SW
March	60	18	33.4	10.17			1.21	288	1.35	5148	45	SW
April	77	25	51.1	.03	3.01	43.0			.55	2867	40	N.SW
May	85	33	56.3	.15	4.75	52.0			.01	3986	40	SW

The Mean Temperature is the Mean of the Daily Means.
Evaporation from a Water Surface was measured in a three-foot pan floated in a concrete basin, the pan being surrounded by one foot of water.

Measurements were made twice daily, 6 A. M. and 6 P. M. in summer and once, 9 A. M. in winter. When frozen the ice was carefully broken away from the sides of the pan and the measurement made. The surface of the water was kept to within two inches of the top of the pan, the conditions were kept as near that of a lake or pond as practicable; during March 1897 it was impossible to make the measurements owing to the heavy snows covering and filling both the pan and the basin. Temperature is the mean temperature of the water one foot below the surface—measurements were made with a needle point.

Measurements of Evaporation from Snow were made by weight and the snow was exposed under as near natural conditions as possible.

Absorption—A three-foot tank of iron was filled with earth, placed in the same condition as found in the hole from which it was excavated, and tamped to its natural compactness; the water which penetrated was drawn off through a pipe and measured. The soil was of a yellow clay underlaid with hard pan; the top was loam and disintegrated granite.

H. B. HEDGES, C. E.

ARIZONA EVAPORATION RECORDS

1920

Location		Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov. (Estimated)	Dec. (Estimated)
Mesa	Evaporation	2.152	2.387	5.563	8.866	11.384	12.039	11.307	9.227	7.911	6.016	3.375	2.763
	Wind movement	873	747	1497	1840	1583	1322	1028	1135	1137	1210	1250	1061
Roosevelt	Evaporation	2.077	2.537	4.875	7.156	10.605	12.402	13.210	10.178	8.529	5.722	2.774	2.425
	Wind movement	960	1003	1564	1707	1244	1419	1481	1430	1109	1125	882	921
Wilcox	Evaporation	2.840	3.755	6.429	8.920	10.915	10.756	11.400	9.452	7.854	5.676	3.450	3.145
	Wind movement	3365	1841	3173	3260	2034	1358	1575	1517	1339	1517	1541	2453
Yuma	Evaporation	2.735	2.980	5.233	6.785	7.307	8.123	9.551	9.253	7.495	5.432	2.749	2.742
	Wind movement	831	807	1140	1374	487	333	464	1193	949	1145	641	736
Average of four stations	Evaporation	2.202	2.630	5.525	7.932	10.052	10.830	11.367	9.577	7.947	5.734	3.087	2.768
	Wind movement	1507	1099	1843	2045	1337	1108	1137	1068	1132	1249	1078	1292

Evaporation recorded in inches. Wind movement recorded in miles per month.
For four stations, average annual evaporation approximately 79.641 inches.

CALIFORNIA EVAPORATION RECORDS
1920

Location		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Chula Vista	Evaporation	2.639	2.918	4.919	6.184	6.354	7.385	7.356	7.413	6.162	4.920	3.533	3.051
	Wind movement	2175	2293	3683	3731	3805	3516	3484	3368	3011	2970	2245	2585
Dodgeland	Evaporation	1.225	2.044	3.138	5.817	9.240	10.212	10.482	8.414	6.191	3.531	1.344	1.018
	Wind movement	1260	1220	1810	2107	2096	2009	1364	770	762	917	1053	1133
Oakdale	Evaporation	1.469	2.304	3.254	5.929	10.947	12.379	14.209	13.990	9.743	4.560	2.223	1.127
	Wind movement	2534	2400	3030	3200	3170	3370	3910	3635	3245	3040	3065	3705
Tahoe	Evaporation	*1.+	*1.22+	*1.54+	4.695	4.880	3.810	6.230	7.090	4.690	2.580	*1.08+	1.00Est.
	Wind movement	2293	1941	....	2613	2118	2180	2153	2073	2021	2333	2428	....

*Record not complete.

Elevation	Total Annual Evaporation
10 Chula Vista, near San Diego	62.825
125 Dodgeland, Sacramento Valley	62.656
215 Oakdale, San Joaquin Valley	82.134
6230 Tahoe	39.815+

SAN JOAQUIN LIGHT & POWER CORP.
CRANE VALLEY LAKE EVAPORATION LOSSES
Values in Inches.

Month	1912	1913	1914	1915	1916	1917	1918	1919	1920	Mean	Percent Annual Total
January	0	0	0	0	0	0	0	0	0	0	
February	0	0	0	0	0	0	0	0	0	0	
March	0	0	0	0	0	0	0	0	0	0	
April	0	0	0	0	0	0	0	2.36	0.671	0.336	0.92
May	3.03	4.50	1.44	0	4.94	3.31	3.73	4.87	4.55	3.38	9.22
June	5.45	4.40	4.51	7.38	6.91	7.45	7.30	7.98	5.86	6.36	17.30
July	9.88	7.26	6.53	8.16	8.72	10.55	9.32	9.74	7.54	8.64	23.52
August	6.88	6.44	8.40	8.35	8.75	10.65	8.16	7.72	6.63	8.00	21.80
September	7.32	5.72	2.87	7.69	6.28	7.37	4.74	5.17	4.71	5.77	16.72
October	5.06	4.63	3.16	5.95	1.21	5.45	2.81	3.05	0.685	3.56	9.70
November	0	0.768	0	0.643	0.250	0.930	.095	0	0	0.298	0.82
December	0	0	0	0	0	0	0	0	0	0	
Season Total	37.62	33.718	26.91	38.173	37.06	45.71	36.155	40.89	30.646		

Annual average evaporation, 36.763 inches.

COMMITTEE

E. J. Crawford, chairman, San Joaquin Light & Power Corp.
P. O. Crawford, California-Oregon Power Co.
R. J. C. Wood, Southern California Edison Co.
I. C. Steele, Pacific Gas & Electric Co.
T. A. Panter, L. A. A. Co.

GOVERNMENT DATA FURNISHED BY

H. D. McGlashan, Dist. Engr., U. S. G. S.
A. H. Palmer
R. Q. Grant

Legislation of Electrical Development in New Countries

BY J. N. Van der LEY

(Development of natural resources has been carried out under governmental regulations in the Netherland East Indies and the following paper, which was read before the first General Engineering Congress at Batavia, shows the idea of regulating the development of hydroelectric resources in a colonial country. The author is Chief Engineer of the Department of Waterpower and Electricity for the government of Holland in the Netherlands East Indies and is at the present time on a visit to the Pacific Coast states examining the present methods of development.—The Editor.)

In many civilized countries of the old world, i. e., in western Europe, during the first stages of the development of the use of electric power, the governments limited themselves to exercising a certain general supervision and to issuing regulations of a technical character, without giving any further guidance or taking any active part in the development of the supply of electricity. The regulations issued in these countries were aimed at guaranteeing the safety of the lives and goods of the inhabitants who supplied electric energy. As a result of this passive attitude of the authorities in these countries, there has been an enormous waste of capital, due to the fact that the generation of the necessary electric energy has been split up among a number of power stations of small capacity, without paying due regard to the possibilities of utilizing the available natural resources.

A further result of the lack of guidance on the part of governments in the matter of the supply of electricity is, that this supply has been confined chiefly to the densely-populated districts, and the large centers of industry, while more distant and thinly-populated parts have had to manage without the blessings of electricity.

The result of the experience thus gained has been that people are trying to realize what course should be adopted for a good and far-sighted policy with regard to the supply of electricity, and have felt the necessity of taking strong measures for leading future developments into the proper channels.

In Holland, in particular, a difficult and tedious process has been going on for about ten years, the result of which will be the disappearance of many of the wasteful power stations of limited capacity, originally started by local authorities and private companies, which will have to make room for a number of large central power stations where the electricity is generated and distributed over the entire country by means of a technically correct network of high tension lines.

Experience acquired elsewhere must, sooner or later, lead to the conclusion that in "new" countries (that is, lands as yet but little developed, colonies, and possessions belonging to Western countries) where the electric supply is still in its infancy, the various governments will have to plan out thoroughly from the very start the manner in which they can best promote the advancement of this industry.

From the foregoing it follows very plainly that the governments of such countries (to which belong also the Netherlands East Indies) will not be able, when taking this matter in hand, to leave it in the hands of private bodies or local boards of management. The endeavor, on the one hand, to obtain the largest possible profits in the shortest time, and, on the other, the partial promotion of the interests of the residents of a limited district, would in this case obstruct the way to the solving of the problem in a universal way while paying due regard to the technical and economical side of the problem.

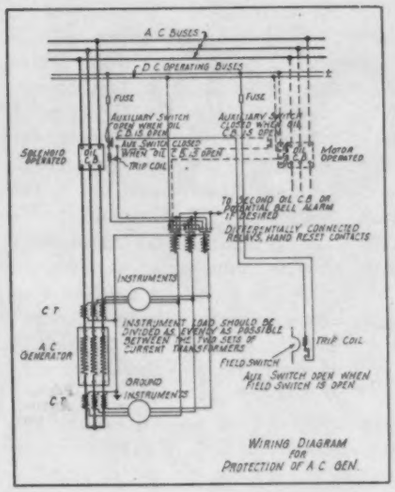


Fig. 1. Showing protection of a generator by means of differential relays.

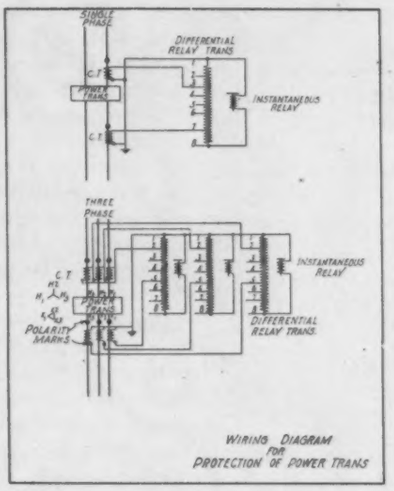


Fig. 2. Showing method of protecting a transformer bank by means of differential relays.

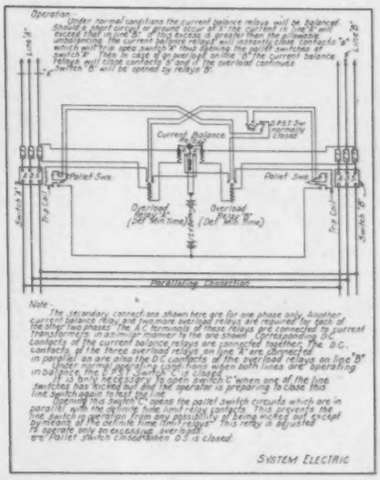


Fig. 3. Showing the use of mechanically balanced current relays for the protection of two parallel lines.

Application and Operation of Relay Systems

BY E. R. STAUFFACHER AND L. J. MOORE

(Due to the diversified character of the apparatus used in electrical systems, the problem of adequately protecting it so that it will not be damaged because of failures from various causes, is becoming increasingly intricate. The paper presented by the Relay Committee to the Pacific Coast Section N. E. L. A. constitutes a comprehensive collection of data on modern practice in this field.—The Editor.)

The different applications of relays to be considered in the year's work were indicated at the first meeting of the committee, and members were urged to collect all information possible on their own systems showing the practice under the different headings. These matters were brought up at each meeting for discussion. The subjects studied will be taken up in order in this report and the general practice and recommendations brought out will be given.

1. Application of relays for protection against internal failure in generators, both in steam and hydraulic plants.

Fig. 1 shows protection of a generator by means of differential relays. This is the usual practice recommended by both the General Electric and Westinghouse Companies, and is the method which has been adopted by all the California companies in the protection of generators wherever possible. It will be noted that both ends of the three-phase windings of the generator are to be brought out and current transformers installed in each. Secondaries of the current transformers are differentially connected so that as long as current is flowing out of the generator to the load and no internal failure exists, no current will flow in the current coils of the relays. However, immediately any internal failure in a winding develops, this balance of current in the damaged phase will be destroyed and the current resulting from the unbalance of the secondaries of the current transformers will pass through one of the relays, thus tripping the generator off the line and opening the electrically operated field switch so as to localize the damage in the machine. Generally the electrically operated field switch is interlocked with the generator oil circuit breaker so that it cannot open until the oil circuit breaker has opened and the generator been disconnected from the line. Actual puncture or failure of the winding, of course, can not be prevented by this protection, but if the setting of the relay is low enough the damaged machine should be removed before very great damage can result. The proper setting of the differential relay is about 20% of the full load capacity of the machine to be protected. It has been suggested that these relays might be arranged to turn water or steam, as the case might be, into the generator to put out the fire, in addition to opening the breakers.

In the case of generators which are already in service, and which have not been constructed with all six ends of the windings brought out, it is not possible to use differential protection. In such cases reverse power relays can be installed between the generator and the bus, the relays being set to operate in case power flows from the bus to the generator. This method gives reasonably good protection, but has the disadvantage that the generator may be tripped off the line during synchronizing unless the operator makes a very good shot.

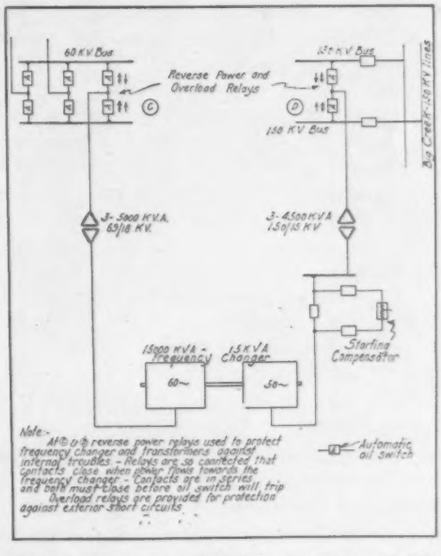

60 KV. Bus
Reverse Power and Overload Relays
150 KV. Bus
Big Creek-150 KV. Lines
3- 5000 KV.A. 65/18 KV.
3- 4500 KV.A. 150/18 KV.
15000 KVA - Frequency
15 KVA Changer
60~
50~
Starting Compensator
Automatic oil Switch
Note:- All of the reverse power relays used to protect frequency changer and transformers against internal troubles - Relays are so connected that contacts close when power flows towards the frequency changer - Contacts are in series and both must close before oil switch will trip. Overload relays are provided for protection against exterior short circuits.

Fig. 1-A. Reverse power relay installed at Southern California Edison Company's Vestal Substation to protect 15,000-kva. frequency changer

2. Protection against internal failure in motor generator sets, condensers and such rotating apparatus.

Rotary converters are ordinarily protected by means of current and low voltage relays on the a.c. side, reverse current relays on the d.c. side and an overspeed device. The low voltage relay on the a.c. side takes the rotary off the line on both the a.c. and d.c. sides as also does the d.c. reverse current relay, in cases of current reversal. The overspeed device is an ultimate protection in case of the failure of the relays.

Synchronous condensers are usually protected by overload and differential relays, the overloads being set very high on account of the fact that it is necessary for the condenser to stay on the line wherever possible. The Southern

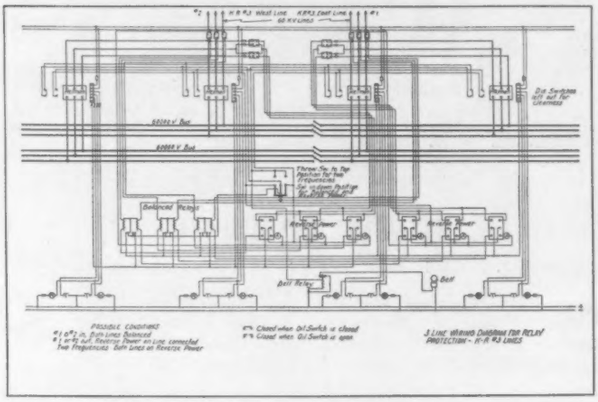


Fig. 4. Showing additional application of the mechanically balanced relay.

California Edison Company protect its 30,000-volt synchronous condenser at Eagle Rock substation by means of an overload relay connected to a current transformer in the neutral of the set which is grounded. The same company has protected its 15,000-kva. frequency changer at the Vestal substation by means of reverse power relays. On account of the different frequencies on the two ends of the set, it was impossible to use differentially connected relays. The final result was the installation of a reverse power relay on the 50-cycle side and one on the 60-cycle side with the tripping contacts in series. Both relays are set to operate for power flowing into the set. If then, the power flows from the 50-cycle side to the 60-cycle side, or vice versa, the contacts of one relay will be open while those of the other will be closed and no operation of the circuit breakers can result. In case of trouble within the set, power will flow in from both sides and both relays will have their contacts closed and trip machines on both lines. It happens that the current transformers operating these relays are in the oil switches on the line side of the transformers of both frequencies. Therefore, the entire substation is protected. See Fig. 1-A.

It has been suggested that rotaries and motor generator sets could be protected against internal failure in somewhat the same manner as the frequency changer at Vestal; that is, reverse power relays could be installed, one on the alternating current side and one on the direct current side with their tripping contacts in series, both relays set to close the contacts when power is flowing into the set. This scheme would, of course, be effective only in case there were always one or more rotaries or converters connected to the d.c. bus. In all cases the d.c. reverse current relay should be set as light as possible.

3. Protection of transformers.

Fig. 2 shows a method of protecting a transformer bank by means of differential relays in much the same manner as that already described for the protection of generators. It will be noted that the protection of large transformers usually requires balancing of the standard type of low voltage current transformer against a bushing type current transformer which is usually installed on the bushing of the high tension transformer oil switch. Changing the taps on the power transformers would interfere with the proper balance of these differentially connected current transformers due to the change in the power transformer ratio. This trouble can be corrected by providing the bushing type current transformer with taps or by the use of an auto transformer as indicated in Fig. 2. Experience with such protection on the San Joaquin Light & Power Corporation's system seems to show that during internal trouble the current through the differential relay is not always the sum of the currents in the secondaries of the two differentially connected current transformers, but seems to be more nearly equal to the current supplied by the transformers on the low tension side of the transformer bank. This, of course, means that the setting of the differential relay must be as low as possible in order to secure proper operation.

The use of transformers having three different windings, or two main windings and a tertiary, is becoming more and more general, and the protection of such transformers is a matter of great interest. Such transformers usually provide for the main transformation of energy between two of the windings with a more or less limited capacity in the third. It appears then that the usual differential protection between the two main windings should be sufficient to protect, providing the setting of the differential relay is sufficiently high to provide for full capacity of the third winding to be utilized, or enough time given to the differential relay to allow breakers on feeders radiating from the third winding to clear.

4. Protection of transmission systems with lines arranged in the form of loops.

The best method at this time for the protection of loop systems is to install reverse power relays on all lines radiating from a substation or power station, the relays being set to trip for outgoing power only. Experience on the Pacific Gas & Electric Company's system and the San Joaquin Light & Power Corporation's system shows such a system of protection to possess considerable merit. The Southern California Edison Company is now installing such a system on an 85-mile loop in the San Joaquin Valley.

The Pacific Gas & Electric Company has been making experiments toward the development of a relay which would operate on overload and have a time limit which would be shorter, the lower the voltage. The use of such a relay would be based on the fact that the voltage is lower close to the short circuit or ground than at any other point on the system. A relay then which would operate quickly on overload at lower voltage, would have a very desirable characteristic for clearing troubles on loop systems. To date no satisfactory relay has been developed, but it appears that some of the manufacturers are taking up the matter.

5. Protection of parallel lines.

Where two or more parallel lines pass between the same two stations, the best method of protection is that of balancing the lines against each other. Figure 3 shows the use of mechanically balanced current relays for the protection of two parallel lines as used by the Southern California Edison Company. This method takes no account of the change of flow of power in the lines but operates very satisfactorily under most conditions. It has the very great advantage of low cost due to the fact that no potential transformers are required. Fig. 4 shows additional application of the mechanically balanced relay.

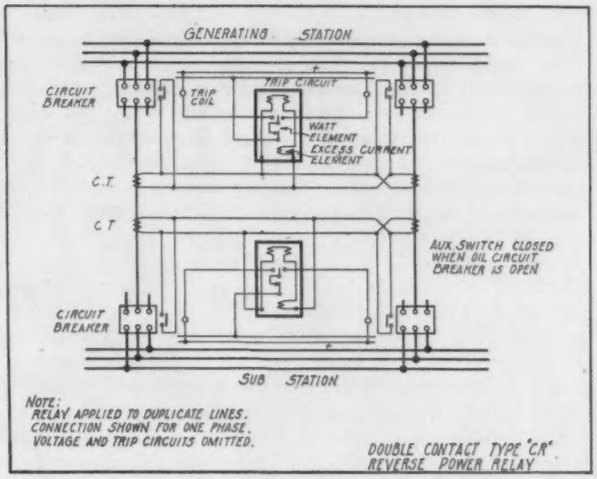

GENERATING STATION
CIRCUIT BREAKER
TRIP COIL
TRIP CIRCUIT
WATT ELEMENT EXCESS CURRENT ELEMENT
C.T.
C.T.
AUX. SWITCH CLOSED WHEN OIL CIRCUIT BREAKER IS OPEN
CIRCUIT BREAKER
SUB STATION
NOTE: RELAY APPLIED TO DUPLICATE LINES. CONNECTION SHOWN FOR ONE PHASE. VOLTAGE AND TRIP CIRCUITS OMITTED.
DOUBLE CONTACT TYPE "CR" REVERSE POWER RELAY

Fig. 5. Method of protecting two lines by means of balancing current transformers in the two lines against each other.

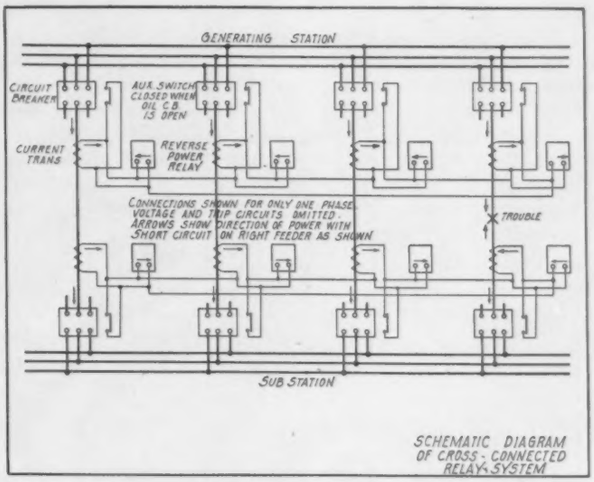

GENERATING STATION
CIRCUIT BREAKER
AUX. SWITCH CLOSED WHEN O.C.B. IS OPEN
CURRENT TRANS.
REVERSE POWER RELAY
CONNECTIONS SHOWN FOR ONLY ONE PHASE. VOLTAGE AND TRIP CIRCUITS OMITTED. ARROWS SHOW DIRECTION OF POWER WITH SHORT CIRCUIT ON RIGHT FEEDER AS SHOWN
TROUBLE
SUB STATION
SCHEMATIC DIAGRAM OF CROSS-CONNECTED RELAY SYSTEM

Fig. 6. Showing reverse power relay balanced protection applied to more than two duplicate lines.

Fig. 5 shows a method of protecting two lines by means of balancing current transformers in the two lines against each other and connecting across the secondaries a double contact reverse power relay. This method takes into account the change of flow of current in the line and provides instantaneous protection when two lines are in service and time limit overload when only one remains. Disturbances then are cleared rapidly and trouble outside the balanced section has no effect on any of the lines which are good. Potential is required by the operation of these relays and this is usually taken from the high tension bus. It is possible, however, to use potential from the low tension potential transformers, thus reducing the cost, the only disadvantage being that in such a connection, there is more chance of the potential being removed from the relay due to some trouble in the station, and of course the relay is inoperative unless both potential and current are applied to it.

Fig. 6 shows the reverse power relay balanced protection applied to more than two duplicate lines. This connection finds its chief application to tie lines between generating station and on loops wherein the various substations are connected by parallel lines and power is fed in at more than one point. In such systems, it is very desirable that the various generating stations shall not become separated, due to the trouble which will be experienced when it is attempted to reunite the loop. The use of balanced relays is one of the most desirable means of securing discriminating protection under these circumstances. The cross-connection also finds an application on systems which are so complex that selective timing becomes impossible. The advantages of the cross-connection are (1) that it can be applied to any system having parallel feeders, (2) it is instantaneous in operation, (3) it can be made to operate on small unbalances of power, such as caused by high resistance grounds. Its chief disadvantages are (1) lack of bus bar protection, and (2) trouble in cutting in new lines which may cause the lines already in service to be disconnected due to unbalanced power. Hence cross-connected relays offer the solution of many difficult problems of protection. Disadvantage (2) could be eliminated simply by the use of switches in the tripping circuits of the oil circuit breakers on all the lines. By opening these switches when it is desired to cut a new line into service or to restore one to service when it had been out for repairs or otherwise, no operation of breakers could occur during the switching. As soon as the switching has been completed and all the lines are connected at both ends, it is only necessary to close the switches in the tripping circuits to obtain protection again.

The Pacific Gas & Electric Company has an installation in San Francisco of four duplicate lines between the power house and a nearby substation. These are protected by overload relays on the power house end and reverse power relays on the substation end. No cross connection between current transformers at either point is provided. The operation has been quite satisfactory to date. The point was brought out, however, in the discussion of the case that if the current transformers in the lines had been balanced against each other, the element of time could have been practically eliminated and instantaneous operation obtained as long as more than one line is in service, and this without any danger of operation from trouble outside the balanced section. Fig. 6 shows application of cross connected current transformers and reverse power relays to such a system.

6. Protection of feeders.

Protection of feeders was discussed at considerable length. The use of bellows type overload relays was considered satisfactory, if they were set for very short times. However, the general opinion was that induction type relays were much preferable. A simple scheme to obtain time limit on oil circuit breakers equipped with transformer trip coils was suggested, which consists of the installation of a fuse in parallel with the trip coil. By varying the size of this fuse almost any time limit desired can be obtained. The higher the fuse the longer the time limit and vice versa. The Pacific Gas & Electric Company's practice in setting of relays on feeders is to set for short circuit operation and not for overload. This is also the case with the Southern California Edison Company.

The Mertz-Price system of protection was discussed for short feeders which run between substations in large cities. The Los Angeles Bureau of Power and Light is interested in this method of protection in that they expect to operate a number of substations and have lines radiating in all directions going from station to station. Balanced protection of parallel lines using reverse power relays at each end with the current transformers interconnected, is not strictly applicable because the lines are not of the same length between stations; therefore, might not equally divide the load. However, the Mertz-Price system using pilot wires to balance the current transformers at opposite ends of the line through suitable relays, seems fairly applicable. This system is in use to a large extent in Chicago and is largely used in England. It seems not to be suitable for the protection of long lines because of the expense of installing the pilot wires, but

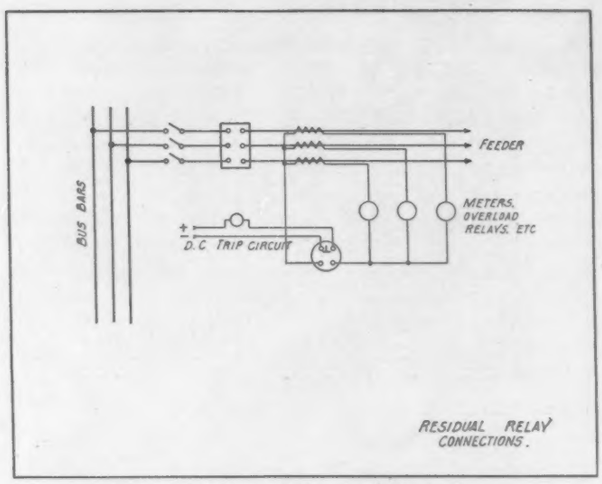


Fig. 7. Showing principle of residual relays.

does give possibilities where the lines are short and the power may flow alternately in different directions.

7. Residual relays (See Fig. 7).

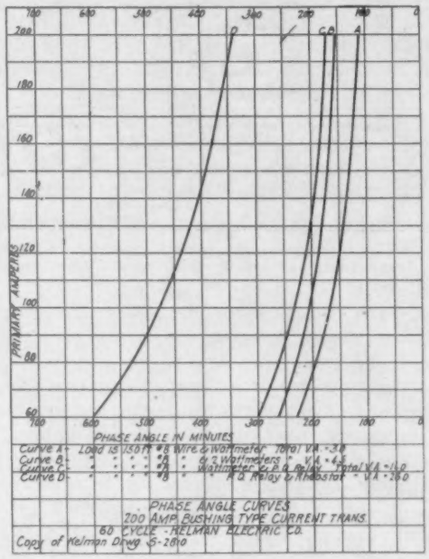
Many systems have experienced difficulty in clearing grounds of low intensity from their systems both in the case of feeders and transmission lines even though the system may be operated with grounded neutrals. High resistance grounds occasionally develop, and currents set up are not sufficient to operate the usual overload or reverse power relays. The residual relay consists of an overload relay connected in the neutral of the three current transformers operating the usual instruments or relays on the circuits. Overloads which are balanced then have no effect on this residual relay and it is operated only by unbalanced currents. It can, therefore, be set very light and may even be a reverse power relay and the direction of the unbalance be taken into account.

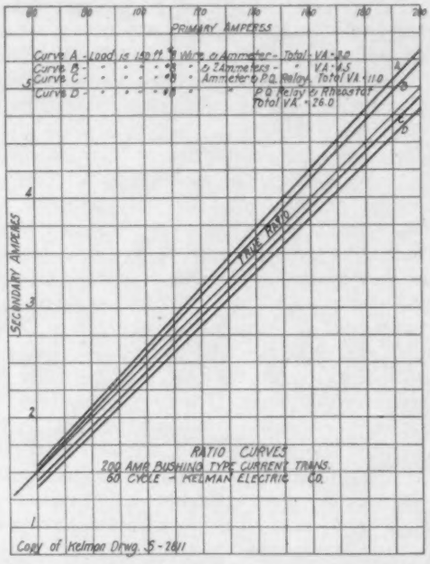
The Pacific Gas & Electric Company has used these relays to a considerable extent and finds them quite satisfactory. Their use has been confined to circuits protected by the use of standard type current transformers and they, therefore, have no difficulty in obtaining sufficient current in the neutral to operate the relays, even in the case of very small unbalances, or rather high resistance grounds, using of course, a one-half ampere relay. The use of such relays in their case removes the lines from service before the grounds can develop to such an extent as to seriously damage the conductors. The use of such relays then is very applicable to systems having underground cables.

Representatives of the Westinghouse Company mentioned the fact that the use of these relays, especially in the case where bushing type current transformers were used, was somewhat unreliable on account of the fact that current, due to an unbalance, had of course more than one path to flow because of the low impedance of the other two bushing transformers providing for division of the current with the neutral. For this reason the Westinghouse company had developed a low energy overload relay which operates on from three to four watts for use under such conditions. Very satisfactory operation can be obtained with such relays.

8. Characteristics of bushing type current transformers.

Considerable interest was shown in the use of bushing type current transformers for relay operation. In view of this interest Figures 8 and 9 are included in this report. These show physical and electrical characteristics of bushing type current transformers manufactured by the General Electric Company and the Kelman Electric & Manufacturing Company of Los Angeles. The question was raised as to the characteristics under heavy short circuit conditions. No data appeared to be available showing any tests made at higher than normal full load currents.* However, the fact that the iron is never worked at anything like saturation seems to indicate that the ratio should hold up well even under the most severe overload. This is borne out by the fact that considerable current through the switch is always required before any appreciable current can be obtained in the secondaries of the transformers. None of the manufacturers attempt to operate at less than fifty or sixty amperes. Bushing type current transformers give satisfactory service for the operation of relays, both overload and reverse power, and for


PRIMARY AMPERES
PHASE ANGLE IN MINUTES
PHASE ANGLE CURVES
200 AMP BUSHING TYPE CURRENT TRANS
60 CYCLE - KELMAN ELECTRIC CO.
Copy of Kelman Drwg. S-2810



Figs. 8 and 9. Showing physical and electrical characteristics of bushing type current transformers manufactured by the General Electric Company and the Kelman Electric Company.

operation of ammeters. On account of their small volt ampere capacity no attempt should be made to connect any more load than that to their secondaries.

9. The proper combination of voltage and current in reverse power relays.

One relay manufacturer advises that in actual practice it has been found that the best combination of voltage and current in reverse power relays is that which causes the current to lead the voltage by 39 degrees under normal conditions. When a short circuit occurs the power factor drops to

*Curves 10 and 11 were submitted after the compilation of this paper.

a very small figure. This action would tend to pull the current more nearly in phase with the voltage until a 30-degree angle was reached, and after that it would tend to pull away again. However, even though the power factor of the short circuit were zero, there would still be proper operation of the relay. Whenever relays are first installed this matter should be checked by applying a single-phase power factor meter to the relay connections. At 100% power factor on the line the current in the relay should lead the voltage by 30 degrees. This can be read directly from the power factor meter and the proper voltage leads chosen. The same results can be obtained by inserting a single-phase watt meter in the circuit and choosing the pair of voltage leads which gives a maximum reading on the watt meter when the load power factor is lagging.

This method of connection involves the use of a corresponding voltage and current, and is made use of in the operation of relays which have no external resistance in the potential circuit. However, the other relay manufacturer works on the assumption that in cases of a short circuit on a given phase the voltage on that phase will become very low, and the best operation can be obtained by connecting the relay with current from one phase and potential from one of the other phases which leads the current by 90 degrees at 100% power factor.

The same relation of current to potential is obtained in the relay itself by the use of an external non-inductive resistance which is connected in series with the potential coil. This external resistance when combined with the reactance of the potential coil of the relay causes a shifting of the potential on the relay coil until it approximates the results obtained with the other connection and the operation of the relay then is always satisfactory.

These two methods of connection are described in Bibliography Nos. 36 and 37.

10. Proper voltage for tripping oil circuit breakers.

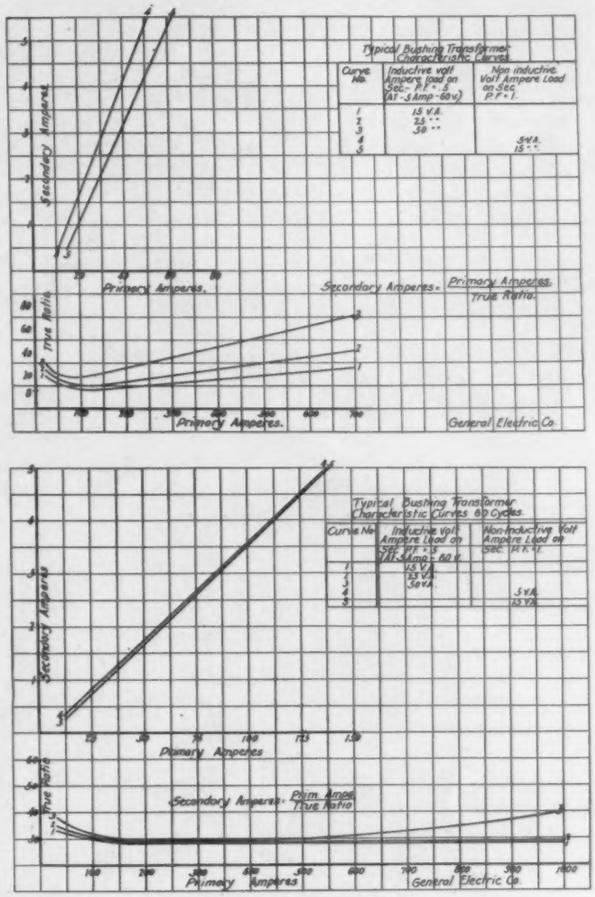
The use of a lower direct current voltage than 110 volts for tripping circuit breakers was discussed. Many companies are using 6-volt automobile storage batteries for this purpose; some are using 12-volt batteries and some are using 32-volt batteries. In all cases where lower voltages are employed, the problem of contact resistance becomes a live one, and contacts of the relays must be carefully inspected and kept in good condition. Kelman Electric and Manufacturing Company uses a nickel-plated metal contact so as to reduce contact troubles with apparently good results. The use of dry cells for tripping breakers was agreed to be poor practice. They are usually run down and in need of changing just when they are needed the most.

11. Advisability of grounded neutrals on systems.

The discussion brought out the fact that for proper operation of relays a grounded neutral at one or more points on the system is almost absolutely necessary. A number of systems over the country who have tried to operate without grounded neutrals are now changing over to this method of operation. One company at least has rewound delta connected transformers so they could be connected in Y and the neutral grounded.

12. Speed of operation of oil switches.

In the proper application of relays to a transmission or distribution system, account must be taken of the speed of operation of the oil switches, and enough time differential must be allowed between relays to insure that a relay with a short time setting will operate enough sooner than the one with the next higher setting of time to allow for the oil switch operated by the first relay to open. Otherwise switches with the longer time setting will often be tripped unnecessarily. All of the larger manufacturers regularly furnish this information regarding their switches. However, this data should be checked occasionally on account of the fact that parts may corrode during a long period of service. There are a number of switches manufactured on the Pacific Coast and no data is available from the manufacturers as to their speed of operation. Companies using these switches, then, should check this point by the use of cycle counters or other such devices. Tests on the Pacific Gas & Electric Company's system on switches of their own manufacture show a speed of operation of about one-third of a second. Tests on


Typical Bushing Transformer Characteristic Curves
Secondary Amperes
Primary Amperes
Secondary Amperes - Primary Amperes True Ratio
General Electric Co.
Typical Bushing Transformer Characteristic Curves 60 Cycles
Secondary Amperes
Primary Amperes
Secondary Amperes - Prim. Amps True Ratio
General Electric Co.

Figs. 10 and 11. Curves showing results of tests made at higher than normal full load currents on bushing type current transformers for relay operation.

large Kelman oil switches on the San Joaquin Light & Power Corporation's system show operation in from one-fourth to one-half second. On account of such an appreciable tie being required for the operation of oil switches, it is very inadvisable for relays to be set with too close time selection. The manufacturers expressed the opinion that the time intervals between the relays should not be less than one-third to one-half second, even though some of their switches operate in not more than one-tenth of a second.

13. Length of interruption.

The relay committee of last year took up the matter of defining an interruption. In other words, it was felt desirable to determine just how long voltage could be removed from the system without actually interrupting service on induction motors. This has been usually stated to be for a period of approximately two seconds, which is considered to be the length of time during which voltage may be entirely removed from the system without induction motors falling so low in speed that they will not pick up again when the

Bibliography

Reference	Title	Author	Month	Day	Year	Vol.	No.	Page
		ELECTRICAL WORLD						
1.	An Installation of Reverse Energy Relays	A. R. Haines	January	23,	1915	65		22
2.	Factors to Consider in Applying Relays	E. A. Hester	November	16,	1918	72	20	931
3.	Checking Differential Relay Installations	Raymond Bailey				75	8	
4.	Taking Full Advantage of Relays	Editor	July	10,	1920	76	2	55
5.	Protecting Industrial Distribution Lines	R. B. Gerhardt	July	24,	1920	76	4	176
6.	Substations for Supplying Large Industries	R. H. Tillman	July	31,	1920	76	5	231
7.	Protection of Transmission Systems, I	Prof. Emil Alm	August	7,	1920	76	6	277
8.	Protecting Parallel Transmission Lines	Editor	September	4,	1920	76	10	462
9.	Current—Balance Relay Protection	E. R. Stauffacher	September	4,	1920	76	10	465
10.	Inspection Tests for Electrical Equipment	A. S. McDowell	September	25,	1920	76	13	633
11.	Special Relay Permits—Use of High Resistance in Neutral Grounds	A. W. Copley	October	23,	1920	76	17	834
12.	Scheduled Inspection for Power Plants		November	6,	1920	76	19	922
13.	Electrical Features of Springdale Plant	Geo. S. Humphrey	December	4,	1920	76	23	1115
			December	11,	1920	76	24	1165
14.	Progress in Relay Protection	Editor	January	29,	1921	77	5	243
15.	Tendencies in Relay Protection	R. N. Comwell	January	29,	1921	77	5	254
16.	Testing Reverse-Power Relays Without Removing Leads	Raymond Bailey	February	5,	1921	77	6	229
		TRANSACTIONS A. I. E. E.						
17.	Artificial Transmission Line	Geo. H. Gray			1917			789
18.	Characteristics of Protective Relays	E. M. Hewlett			1912	31 (I)		175
19.	Characteristics of Protective Relays	Ruffner, McAllister, Osgood, Maelloux, Badear, Hewlett, Burnham, Lof			1912	31 (I)		198
20.	Relay Protective Systems	L. L. Elden			1912	31 (II)		1911
21.	Relay Protective Systems	Roper, Osborn, Nicholson, Creighton, Elden			1912	31 (II)		1932
22.	Experience—Protective Features	N. L. Pollard and J. T. Lawson			1916	35		695
23.	Experience—Protective Features	P. H. Chase, et al	June		1916	35		724
24.	The Restoration of Service after a Necessary Interruption	F. E. Ricketts	June	27,	1916	35		635
25.	The Restoration of Service after a Necessary Interruption	Goodwin, et al	June	27,	1916	35		649
26.	The Protective Equipment on the System of the Commonwealth Edison Co	R. F. Schuchardt			1917	36		377
27.	Relays for High Tension Lines	Philip Torchio			1917	36		361
28.	Relays for High Tension Lines and the Protective Equipment, etc	Summerhays, et al			1917	36		390
29.	Split Conductor Cable—Balanced Protection	W. H. Cole			1918	37		757
30.	Split Conductor Cable—Balanced Protection	Taylor, et al			1918	37		785
31.	Transmission Line Relay Protection	Woodrow, Roper, et al			1919	38 (I)		795
32.	Transmission Line Relay Protection	Craighead, et al			1919	38 (I)		839
33.	Protection of Transformer Neutrals Against Destructive Transient Disturbances	Max. H. Collbohm			1917	36		135
		HYDRO-ELECTRIC POWER STATIONS						
34.	Systems of Connections and Relay Protection	Lof and Rushmore	October		1917			486
35.	Relays	Lof and Rushmore	October		1917			507
		POWER						
36.	Protective Relays—Reverse-Power Type	L. A. Fitts			1920	52	25	987
37.	Protective Relays—Power Type		November	2,	1920	52	18	689
38.	Reverse Power Relays		July	15,	1919	50	3	
39.	Timing Relay with a Cycle Counter				1920	52	19	751
40.	Testing D. C. Relays				1920	52	22	850
		BOOK BY McGRAW-HILL BOOK CO.						
41.	American Hydro-electric Practice	Wm. T. Taylor and D. H. Braymer			1917			248
		LONDON ELECTRICIAN						
42.	Overload Protection on Alternating Current Circuits by Tripping Device	C. C. Garrard	January	29,	1915			
43.	Automatic Protection Devices for A. C. Systems	A. E. McColl	May	21,	1920			
		ELECTRIC JOURNAL						
44.	Protection of Transmission Circuits by Relays	F. E. Ricketts	April		1914	11	4	227
45.	A Load Proportioning Arrangement	B. H. Smith	May		1914	11	5	285
46.	Overload Relay	D. A. M. and B. H. S.	May		1914	11	5	291
47.	A Series Transformer Tripping Device for Circuit Breakers	B. H. Smith	November		1914	11	11	620
48.	The Selective Time Element of Relays	Paul McGahan	March		1915	12	3	91
49.	The Relay as a Load Builder	Edited by F. E. Ricketts	March		1915	12	3	90
50.	A Special Application of Overload Relays	M. Cornelius	August		1915	12	8	336
51.	Reverse Phase Relay Magnet	H. M. N. and W. D.	October		1915	12	10	492
52.	Advantages of the Z Connection	A. J. A. Peterson	November		1915	12	11	522
53.	Shunt Field Protective Relays	J. H. Albrecht	December		1915	12	12	566
54.	Reverse Power Relays	P. McGahan and B. H. Smith	September		1915	12	9	1417
55.	The Use of Protective Relays on Alternating Current Systems	L. N. Crichton	July		1916	13	7	339
56.	Relay Operation on Heavy Short Circuits	L. N. Crichton	November		1917	14	11	463
57.	Recent Protective Relay Development	E. A. Hester	June		1918	15	6	217
58.	Gounded Neutral on A. C. Generators	S. L. Henderson	August		1919	16	8	34
59.	Standard Automatic Substation Equipment	R. J. Wensley	May		1919	16	5	218
60.	Switching and Protection of Transmission Circuits (IV)	S. Q. Hayes	December		1920	17	12	555
61.	Typical Relay Connections	Louis A. Terven	January	1,	1921	18	1	29
62.	Switching and Protection of Transmission Circuits	S. Q. Hayes	June		1920	17	6	263
		GENERAL ELECTRIC REVIEW						
63.	Relays and Their Use with Power Circuits	E. H. Jacobs	March		1911	14	3	110
64.	Switchboard Relays and Their Applications	D. B. Asch	April		1913	16	4	242
65.	A New Time Limit Overload Relay	H. G. French	October		1916	19	10	853
66.	Some Developments in the Electrical Industry During 1917	John Liston	January		1918	21	1	4
67.	Time Limit Induction Overload Relay	F. E. Jacquay	October		1918	21	10	704
68.	Developments in Switchboard Apparatus		July		1919	22	7	535
69.	Relay Protection for Large Power Stations	O. C. Traver	November		1919	22	11	885
70.	The Alabama Power Company's System	Oliver, et al	November		1919	22	11	980
71.	The New England Power Company	E. A. Dillard	November		1919	22	11	974
72.	Alternating Current Network Protector		May		1920			
73.	Some Developments in the Electrical Industry During 1919	John Liston	January		1920	23	1	4
		ELECTRICAL REVIEW						
74.	Merz-Price System of Cable Protection	C. W. Marshall	August	8,	1919	85	2176	165
		WESTINGHOUSE E. & MFG. CO. PUB. NO. 1572-A						
75.	Protective Relays, Their Use on A. C. Systems	Westinghouse E. & M. Co	April		1919			
		ELECTRICAL ENGINEER (LONDON)						
76.	Switch Gear and the Isolation of Faults on Power-Supply Systems	H. W. Clothier	December	30,	1910			
		JOURNAL INSTITUTE OF ELECTRICAL ENGINEERS (LONDON)						
77.	Automatic Protective Switch-Gear for A. C. Systems	E. B. Wedmore	January	15,	1915			158
		JOURNAL OF ELECTRICITY						
78.	Relay Protective Systems	G. E. Armstrong	April	15,	1919	42	8	349

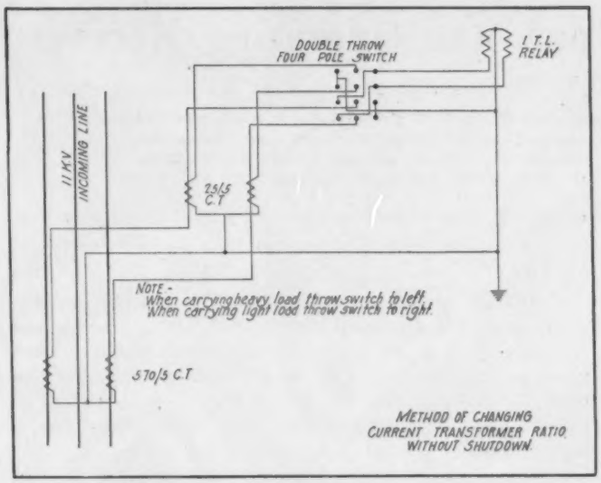


Fig. 12. Showing method used by San Diego Consolidated Gas & Electric Company for changing the ratio of current transformer without shut-down of the circuit.

voltage is restored. This point is of importance in determining setting of relays or in determining the length of time during which disturbances are allowed to remain on the system. It is not a simple matter to define on account of the fact that many disturbances do not entirely remove the voltage from the system. Also different classes of load have different characteristics and motors running on one class will not slow down as rapidly as those running on other classes. It was found advisable to make a number of experiments along this line but owing to the lack of proper instruments and equipment, nothing as yet has been done.

14. Maintenance of relays.

The proper inspection of relays is obviously a matter of great importance in that relays are merely for the proper operation of oil switches in order that cases of trouble may be cleared and apparatus protected. The only way in which this protection can be obtained is for the relays to be kept in the best possible condition at all times. The committee recommends that bellows type relays be inspected at intervals of not more than three months and induction type relays be inspected at intervals of not longer than six months. Bellows type relays are apt to give trouble from hardening of the leather, from dirt collecting in the needle valve and from contact difficulties if the tripping current is at 20 volts or below, and the contacts are circuit closing. Experience has shown that with circuit closing relays of the bellows type setting had entirely changed at a period of six months after adjustment. These inspections should preferably be made by a representative of the test or meter department of the company under the direction of the engineer who is responsible for the application and operation of the relays on the system. Actual operation of the switches should be had at the time of testing the relay, if at all possible. In a number of cases the failure to actually operate the switch has resulted in failure of operation at a time when trouble occurred. The cover of the relay should be removed and the contacts closed by hand, thus checking the tripping circuits and noting the operation of the oil switch. Some companies arrange for the operator at the substation to perform this operation at intervals of not more than a week. However, the committee does not believe this is the proper practice. Such operation of relays and breakers should always be done by some one experienced in relay work.

Suggestion has been made that the switch could be operated without opening the relay case, by simply applying a short circuit across the contact terminal studs and in this way even unskilled workers could check up the tripping circuits. The committee recommends that test links or calibration switches be installed on relays in the same manner as in the case of watthour meters in order to facilitate checking the relay setting. Cycle counters provide the best means for checking time settings, especially in case of settings of one and one-half seconds or less.

Fig. 12 shows method used by the San Diego Consolidated Gas and Electric Company for changing the ratio of current transformers without shut-down of the circuit. This scheme provides an easy way of taking care of different loads over a circuit or where changes in the amount of load are made at frequent intervals.

15. Bibliography. (Page 502.)

It was felt by the committee that a list of articles in the technical press covering the application, operation and testing of relays might be of great use to engineers of member companies. With this idea in mind, the accompanying list of articles with their authors, name of publication, page, etc., has been compiled.

COMMITTEE ON RELAYS, PACIFIC COAST SECTION, N. E. L. A.
E. R. Stauffacher, Chairman, M. H. Schnapp, J. E. Bridges, J. Mina, C. E. Copeland, L. J. Moore

ENGINEERS OF YESTERDAY

(Series Compiled by A. L. Jordan)

OERSTED [1777-1851]

23. OERSTED

What was the "electric conflict"?

Hans Christian Oersted, a Dane (1777-1851) was the discoverer of electromagnetism. The electric current was made known to the world by Volta, in 1800, but for 19 years no one suspected a relation between it and magnetism. Oersted, it seems, was arranging a magnetic needle for experimenting during a storm and, happening to place a platinum wire bearing current near the needle, observed its deflection. He soon found that the result was not affected by the kind of wire, but was caused by the "electric conflict," as he called it, around the wire. It is what we call a magnetic field, and the shape of the force-lines can be shown by iron filings or by a compass needle. The direction of the force-lines (that in which a N. magnetic pole is urged) is as follows: "If you are looking in the direction of the current, the force-lines travel clockwise."

Operation for Maximum Output, and Operating Records

BY GEO. H. BRAGG

(Economy is not always a limitation of expenditure, but the art of getting the utmost possible value out of available resources. The report of the sub-committee of the Hydraulic Committee to the Pacific Coast Section N. E. L. A. presents important data on efficient power plant operation, as the result of an investigation of a number of western systems.—The Editor.)

OPERATION FOR MAXIMUM OUTPUT

From the reports received from the various companies, it is evident that "Economy" is the watchword of each.

Some of the plants are "blessed" with modern and accurate devices to determine efficiency at frequent intervals, while others must rely on more or less crude ones. Whether

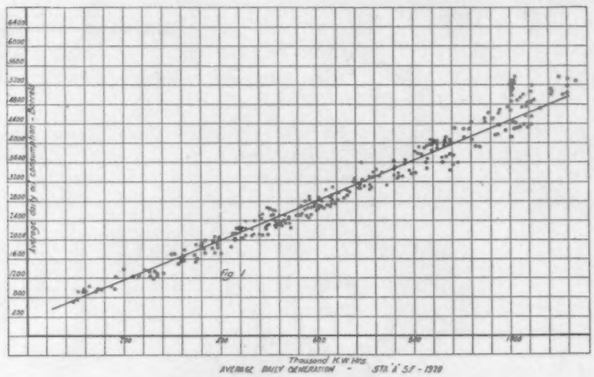


Fig. 1. Plant Characteristic diagram for a steam-electric station, showing the oil consumption plotted against the kw-hr. generated. Each point on the diagram represents one full day's operation.

some records are more accurate than others is somewhat immaterial, as the moral effect in both cases is productive of the maximum kw-hr. output from the equipment for a given quantity of water or steam.

Remote control indicators play an important part by supplying the operator in charge of the plant with accurate information at all times.

Obtaining Maximum Output

The usual methods of obtaining maximum output are enumerated below:

(1) Shifting the load to the larger and more efficient units and shutting down or motoring the older and less efficient ones whenever possible.

(2) By using flash boards in the forebay or storage reservoir to (a) increase the effective head on the plant, (b) increase the storage when the floods have subsided.

(3) By regulating with one hydro plant or with steam plant and blocking all other governors to hold constant load on all other units.

(4) By adjusting the load between the hydro and steam plants to give the best average efficiency on both.

(5) By carefully locating and stopping all leaks and waste.

Of special interest in the reduction of leakage are the methods described below:

In a five board "set-up" of flash boards, four boards are placed in the usual manner, but the fifth is bolted to the supports, leaving a crack of one and one-half inches between it and the top of the fourth board. Wedges are then driven in to close the cracks between the top board and those below. Finally, a batten is nailed over the large crack on the outside. This arrangement aids the silt and debris in stopping all leakage.

Leakage in flumes due to ice, etc., has been successfully reduced by scraping sand or preferably clay in at the head works. Caution should be observed in this practice, however, as it may cause excessive wear of nozzles, buckets and turbine parts.

In the case of steam plants, efficiency tests should be conducted when the equipment is first put into service and any changes or adjustments to minimize the losses should be made at that time. Having determined the maximum economy, the operator has but to watch his kw-hr. output per barrel of fuel oil burned to know that he is maintaining the best efficiency.

In the course of time when it becomes necessary to disassemble units for overhauling and maintenance, care should be exercised to make sure that all readjustments are properly made. As an instance, it has been found that nozzle settings

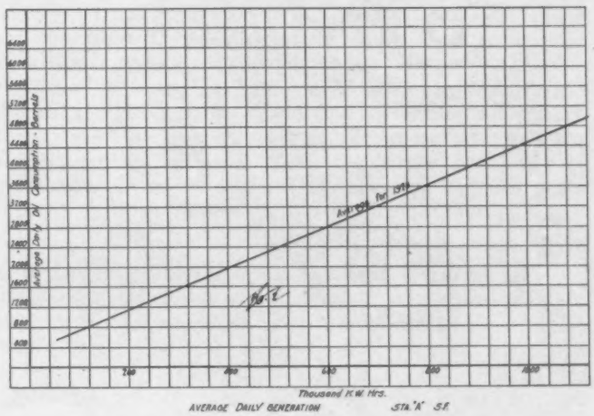


Fig. 2. Plant Characteristic diagram with same diagonal line as determined by Fig. 1, but with the points omitted.

on impulse wheels have been found to lower the efficiency after reassembling, and in checking up it was discovered that the impulse circle had been changed by the control mechanism.

Relief valves on turbine should receive careful inspection for leakage due to wear of the seats.

Steam Plant Efficiency Curves

In order to improve steam plant conditions and to interest the men in the problem of efficiency, the Pacific Gas & Electric Company has devised a system of comparing the performances from day to day by means of charts.

Figure 1 shows the Plant Characteristic diagram for one of the stations. It consists merely in the plotting of the oil consumption against the kw-hr. generated. Each of the points in this diagram represents one full day's operation, and while the points as shown on the diagram are more or less scattered, it is apparent that they form a well defined line. It is thus possible to draw a straight line through the midst of them in such a way that it will represent the average location of all the points of the diagram. There is nothing new in the use of a straight line diagram, such as is presented. The line is similar to the Willans lines for steam engines where the total steam consumption of an engine plotted against the horsepower output is always found to be

a straight line for throttling engines. A similar line for steam turbines is either straight, or very nearly straight, depending on the design of the turbine.

The diagonal line, having once been drawn through the points as described, may be used as a standard for the guid-

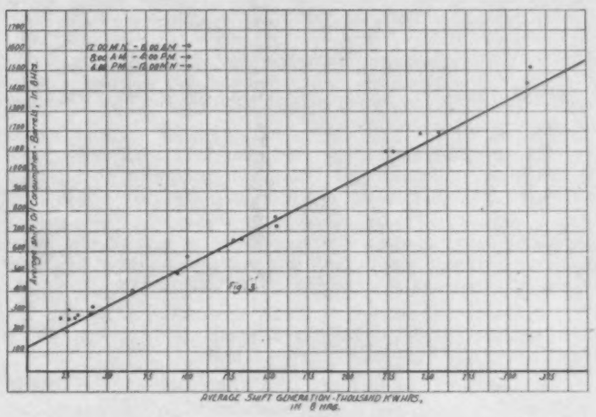


Fig. 3. Plant Characteristic diagram similar to Fig. 2, but with scale altered to show kw-hr. generated and oil burned during a period of eight hours instead of 24 hours.

ance of the men in future operation of the plant. Thus each day the kw-hr. generated and the oil burned the day before, may be plotted on this diagram. If the point so plotted is found to fall below the diagonal line, it is evident that the results obtained are better than the standard. If the point falls above the line, too much oil has been used, and there is something wrong requiring a special investigation; and since the diagram takes in all loads from zero up to the full load on the plant, it is evident that it allows for the poor economy obtained at light loads. It is thus possible for the operating men to know immediately whether they are keeping up to the required standards of efficiency or running behind. They are therefore able to investigate causes of low efficiency immediately, while all matters entering into the plant operation are fresh in their minds.

In adopting the standard, it would be possible instead of drawing a line through the average of the points, to draw a line through the best points, thus establishing a standard that would represent the best results obtainable from the plant. Again, it would be possible to establish a standard by drawing a theoretical line below all of the points, this line to be based on the steam consumption of the turbines and auxiliaries, as determined by tests, a boiler efficiency of, say, 80% and the best possible vacuum. In other words, a line representing ideal conditions.

In adopting the average line as the standard, it is felt that the men will have greater confidence in the method than if a theoretical line had been adopted. The average line is really a standard that has been established by the men themselves. It is not an arbitrary ideal impossible to attain, but as it represents the average already attained, it should be as easy to improve on the results represented by the line as to fall below them.

If the men are successful in improving on the standard each day, it is obvious that the average for the present year will represent better efficiency than the average for the previous year. With all of the points falling below the line on the diagram, another line drawn through the average of these new points would also fall below the original line.

Figure 2 shows a diagram with the same diagonal line as determined by Fig. 1, but with the points omitted; this diagram may be used at the stations each day to plot the results of the day before.

Figure 3 shows a similar diagram, but with the scale altered so as to show the kw-hr. generated, and the oil burned during a period of eight hours, instead of 24 hours. This diagram may be used by the different shifts in the station so that each shift can check up his own performance and compare it with the performance of the other shifts. A large diagram of this form is posted on the wall of the fire room, and different colored pins to represent the different shifts are inserted each day so that the diagram shows at all times which shift is running above the line and which shift is running below the line. This system has a far-reaching effect in the awakening interest of the men, and leads to rivalry and competition so that the men are extremely anxious to improve the efficiency, and the laxity which previously existed in regard to efficiency disappears. As the diagram allows for variation in load, it is possible to compare the day shift when the load is heavy with the early morning shift when there is very little load on the plant, thus making a fair comparison which was never possible with the old method of merely figuring the kw-hr. per bbl. of oil.

Establishing a Standard

There is one objection to the diagram, namely, the fact that it does not indicate the order in which the records are plotted, and therefore does not show whether the results are improving as time goes on. In order to overcome this objection, and also to enable the operation of different plants to be compared with each other, the term "Operating Efficiency" has been introduced. Operating efficiency as used in this connection means the per cent of standard attained for the

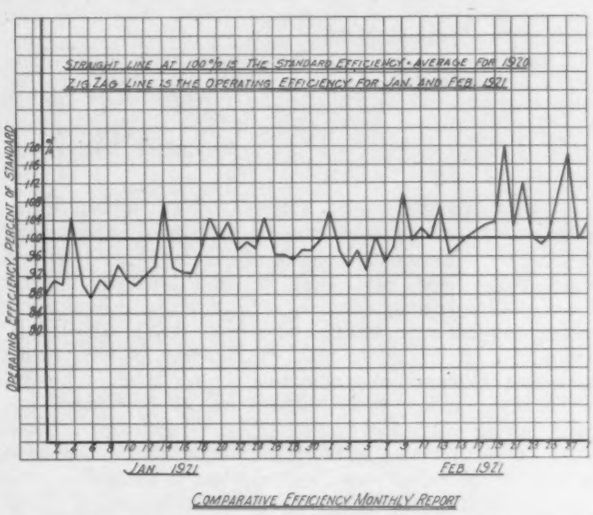
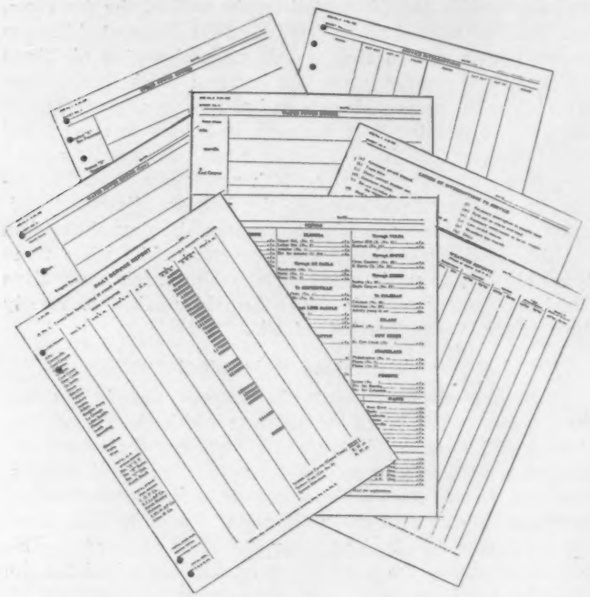

STRAIGHT LINE AT 100% IS THE STANDARD EFFICIENCY - AVERAGE FOR 1920
ZIG ZAG LINE IS THE OPERATING EFFICIENCY FOR JAN. AND FEB. 1921
OPERATING EFFICIENCY - PERCENT OF STANDARD
JAN. 1921
FEB. 1921
COMPARATIVE EFFICIENCY MONTHLY REPORT

Fig. 4. Operating efficiency of a steam-electric plant plotted for each day of January and February. The horizontal line at 100% represents the standard efficiency, and the zigzag line the actual operating efficiency obtained each day.

day's run. "Operating Efficiency" is entirely distinct from "Boiler Efficiency" or "Turbine Efficiency" or "Thermal Efficiency" or "Rankine Cycle Efficiency." All of these entered into the operation of the plant in determining the standard. Operating Efficiency is merely a comparison of the results actually obtained with the standard. The method of determining operating efficiency can best be shown by an example: During one eight-hour shift there were generated 313,000 kw-hr. and 1440 bbls. of oil were burned, representing an economy of 217 kw-hr. per bbl. From the diagram it is found that for a load of 313,000 kw-hr. with standard efficiency, there would be burned only 1400 bbls. of oil, which would be equivalent to 224 kw-hr. per bbl., as against the actual results obtained of 217 kw-hr. per bbl. The operating

efficiency is therefore 217 divided by 224 equals 97%. During another eight-hour shift, while there were only 25,000 kw-hr. generated, the oil burned was 200 bbls., equivalent to 125 kw-hr. per bbl. From the diagram it is found that for 25,000 kw-hr. with standard efficiency the oil burned would be 200 bbls., equivalent to 114 kw-hr. per bbl. The operating efficiency is therefore 125 divided by 114 equals 110%. It is thus seen that although in the second case there were only 125 kw-hr. per bbl. obtained, as against 217 in the first case, the operating efficiency was actually higher in the second case than in the first.



Eight forms used by the Pacific Gas & Electric Company in recording operating data for all plants throughout the system. The different sheets are described in detail in the text.

It is evident from the above that if an operating efficiency of 100% is obtained, it means that the economy of the plant is the same as the average of last year, since the last year's records were used to establish the standard. If more than 100% operating efficiency is obtained, the results are better than last year, and if less than 100% is obtained, they are worse. It is obvious that this method of determining operating efficiency makes allowance for inefficient machinery, and it is just as easy to obtain 100% operating efficiency in a plant having old-fashioned turbines of poor design as in a plant having the most up-to-date machines, for the standard is based on the actual records of the plant in question.

Figure 4 shows the operating efficiency of one of the plants plotted for each day during the months of January and February. In this diagram the horizontal line at 100% represents the standard efficiency, and the zigzag line represents the actual operating efficiency obtained each day. The records show a gradual improvement in the operating efficiency during the period, which is a direct result of the attention to small details brought about by this method of checking up efficiency.

System of Reports

In addition to the use of the diagram for setting standards and creating interest among the men, a system of weekly and monthly reports and bulletins has been adopted. The weekly report, which is made out by the efficiency man at each station, gives the operating efficiency for each day and the average for the week, and in addition a brief statement of some of the more important instrument readings such as flue gas analysis, vacuum, feed water temperature and steam consumption of turbines at different loads. The monthly report which is made out at the office and sent to each station includes a diagram of operating efficiency similar to Figure 4 for all stations plotted on one sheet, together with a brief statement of comparative results obtained and suggestions for improved methods. A liberal use is made in the stations of flow meters and other instruments that serve as a guide to the firemen in the proper regulation of their fires.

Maintaining the Highest Efficiency

To sum up, the essentials for securing the best efficiency in power plant operation are:

1. A fair standard by which the daily performance can be measured, and compared with previous results, at the same time giving the operating men a definite goal to work on.

2. Means of comparing results obtained by different groups of men, such as different shifts of one plant or the crews of different plants, and the posting of this comparison so that the men can see the results of their efforts.

3. A system of reports that keeps up the interest of the men, combined with suggestions and advice that show where losses occur and how they may be avoided.

If the operating men are kept interested, see the results of their work, and have a definite standard to reach they will do their best. As interest flags some sort of bonus or prize for the crew showing the best operating efficiency will stimulate them to greater effort, and by guiding this effort by means of thoughtful analysis of the technical features of the power plant, maximum efficiency may be obtained.

OPERATING RECORDS

The daily operating records of the smaller systems comprising two or three plants are quite complete and include all of the switchboard readings and in some cases a load curve.

In the case of a large system the log of the daily performance presents a more complex problem. A description of the present form used by the Pacific Gas & Electric Company may be found of interest.

This system consists of 24 hydroelectric plants, 4 steam plants, 30 storage reservoirs, 837 miles of flumes, ditches and canals, and 3,000 miles of high tension or primary transmission lines.

Numerous operating records of a local nature are kept by the various substations, power houses, and divisions or district offices. These cover data pertaining to line and load conditions, etc., affecting individual stations or small sections of the system, and of course furnish a mass of valuable information. However, these reports and records are of so voluminous a nature as to render it impossible for a man whose time is limited, to keep in daily touch through them with operating problems and important developments on the system as a whole.

To meet the demand for a digest of operating data, the Pacific Gas & Electric Company has developed a record known as the "Daily Service Report," which summarizes in concise and intelligible form all essential factors of the operation of the company's system, and furnishes in a single tabulation the daily figures from which the monthly and annual records of kilowatt-hour output, peak demand, water storage, stream flow and other essential data are compiled.

The "Daily Service Report" has passed through numerous stages of development from its first appearance as a single letter size sheet, with its crude record of a few lines of more or less reliable information, to the present form of eight ruled and printed sheets, with space for nearly every item of interest to the company's engineers and officials.

A detailed description of this report would of necessity consume much time, and possibly be of little interest to many,

but the following notes may prove of some assistance to any of our member companies who may be using or developing records of this kind.

Considering each sheet in the order of its importance,—

Sheet No. 1 is the groundwork of the entire report, containing, as it does, the figures upon which all the company's records of power generated and purchased are based. These figures are subdivided into seven groups, each group being complete for every hydroelectric and steam-electric plant on the system, and also for each company from which the Pacific Gas & Electric Company purchases energy. The names of the generating plants and foreign companies are arranged in alphabetical order on the left-hand margin of the sheet, the balance of the space being divided into eight columns, as follows:

Column No. 1—**Maximum Kilowatts.** (The heaviest load of 5-minute duration occurring at any time during the 24 hours.)

Column No. 2—**Average Kilowatts.** (The total kilowatt-hour output for the 24 hours of the day, as shown in Column No. 4, divided by 24.)

Column No. 3—**Peak Kilowatts.** (Represents the loads carried by the several generating stations at the time the heaviest load occurs, regardless of the duration of such load.)

Column No. 4—**Kilowatt-Hours.** (The gross kilowatt-hour output for the several stations for 24 hours. It includes station uses and local consumption about the plants.)

Column No. 5—**Possible Kw-hr.** (Represents the energy that might be delivered to the system with a normal full head of water in canals, a normal number of boilers in service, and no generating equipment or lines out of service; i. e., it represents the maximum possible output of the stations operating under the most favorable conditions, and at maximum efficiency when first installed.)

Column No. 6—**Available Kw-hr.** (The estimated energy which could be delivered after the limitations imposed by Column No. 8 have been considered.)

Column No. 7—**Available Peak Kw-hr.** (The maximum possible simultaneous output that could be carried by the several stations for a period of two hours during the peak load—see Column No. 3.)

Column No. 8—(Prefix letters under this column indicate that columns No. 6 and No. 7 are limited for the following reasons: (a) Ditches, flumes and pipe lines; (b) Draft on storage; (c) Boilers; (d) Prime movers; (e) Transformers; (f) Generators; (g) Lines; (h) Out of commission temporarily; (i) Terms of contract; (j) Low water; (k) Water diverted for irrigation.) The explanation of Columns No. 1 to No. 8 is printed on the reverse side of Sheet No. 1, leaving the face of the sheet clear of unnecessary detail. The totals of the figures in Columns Nos. 2, 3, 4, 6, and 7 divide as Hydroelectric, Steam-electric, Power Purchased, these subtotals footing up to the grand total for the day. In addition, there is carried at the bottom of this sheet a space for System Load Factor, System Minimum Load (with time of its occurrence), and for System Peak Kw. (with time of its occurrence). Any energy delivered to an interconnected company for exchange purposes (not covered by contract), is deducted from the grand total in order to arrive at the net system figure for the day.

Sheet No. 2 carries a resumé of system water records. The upper part of this sheet is devoted entirely to canals and diversions; each water system with its canal and stream gages handled under a separate heading. Canal and stream gages noted on this sheet are only those which are of interest from a standpoint of power generation; canals which supply water for irrigation or domestic purposes only being disregarded, except in cases where diversion is made at a point where the output of a hydroelectric generating station may be affected thereby. The lower section of sheet No. 2 carries records of Storage Reservoirs, Forebays and Waste Water over Head Dam. A daily report of Forebay content in Acre Feet, Storage Reservoir content in Acre Feet, and Waste Water over dams in cubic feet per second is here kept; space being provided for each item under printed headings. In connection with forebay content, a printed table of capacities is also provided, thereby making it possible to check at a glance the water conditions at any given hydroelectric plant. Readings of canal gages, forebay heights and waste water records are based upon these figures. On the reverse side of sheet No. 2 is printed a table of stream, canal and waste water gages, showing their location and stating exactly what part of the water supply or diversion is measured by each gage. On smaller systems it might prove advisable to show this data by means of a diagram, but the size and ramifications of the Pacific Gas & Electric Company's water system render such a method impracticable, if not impossible.

Sheet No. 3 is devoted to weather reports, and shows weather conditions; maximum and minimum temperature (for the 24 hours); snowfall for day for past and present year; rainfall for day, with comparative figure for past year; seasonal total precipitation to date for current and past year; and depth of snow on ground at date for the two years. Locations from which this data is obtained range from sea level to over 7000 feet elevation, and cover the state of California from the Summit and Battle Creek on the east and north to Salinas in the south. All weather reports are taken at approximately 5:00 p.m.

Sheet No. 4 carries a brief statement covering any case of line or equipment failure, etc., which affects the system as a whole or in part. Secondary line trouble or low tension equipment failure which affects local service only, is not noted on this sheet. A case of system trouble which causes service interruptions at one or more stations, or entails the separation from the system of any generating plant of foreign company, is assigned a reference letter in the order of its occurrence, this letter being used on Sheets Nos. 5, 6, 7 and 8 to simplify recording of interruptions, etc. At the top of Sheet No. 4 is a printed tabulation headed "Causes of Interruptions to Service," this being a list of common causes, such as "Automatic switch tripped,"—"Fuses blew,"—"Interruption for line work,"—"Secondary line trouble,"—"Error,"—"Line switch repairs," etc. Each cause on this list is represented by a lower case letter, and these letters are used in recording interruptions on Sheet No. 8, to reduce necessary written explanatory matter to a minimum.

Sheets Nos. 5 and 6 are devoted to details of operation affecting hydroelectric generating stations, each plant being assigned sufficient space to allow notation of all unusual conditions affecting the output of the plant, such as, ditch or flume trouble, generator or transformer trouble, etc. Under these headings are also carried notes on construction or maintenance work, and any references to trouble recorded on No. 4 sheet that may have affected the particular plant in question. It will be noted that Sheets Nos. 5 and 6 are very closely related to Sheet No. 1, as any variation in output, etc., as recorded in the tabulation on Sheet No. 1 may be checked for cause by reference to Sheets Nos. 5 and 6.

Sheet No. 7 serves for the Steam-electric generating stations and for the inter-connected companies the same purpose as is served by Sheets Nos. 5 and 6 for the hydro-electric plants; and the same methods of preparation are used, proper notation being made of condenser, boiler or tube maintenance, repairs or trouble at the steam electric plants. As regards the companies delivering energy in to the Pacific Gas & Electric Company system, record is kept of the number of hours in parallel and any unusual conditions arising from the inter-connection. No attempt is made to record operating de-

tails on systems of foreign companies except as they affect service maintained to consumers of the Pacific Gas & Electric Company.

Sheet No. 8 is devoted to Service Interruptions, and carries four columns headed respectively—"Station"—"Cut Out" "Cut In"—"Cause". Under the first head is placed the name of the station affected, followed by names of circuits interrupted. The second and third columns take care of time of interruptions, and in the fourth column are placed the proper reference letters to show cause for the interruption, as explained under notes on Sheet No. 4.

The foregoing explanation covers in outline the procedure followed in making up a record that has been found to be as nearly complete as is practicable for a large transmission system; containing in condensed form all the essentials for a day-to-day analysis of almost every item that enters into the operation of such a project.

The preparation of the "Daily Service Report" is interesting in itself, and entails considerable work. Briefly, the method may be outlined as follows:

The Load Dispatcher's office is charged with the task of collecting reports from each generating plant and switching center; these reports covering details of operation at all the stations, such as low and high tension switching, apparatus failures, maintenance work, line trouble, clearances for line or station work, etc. Eight eight-hour shift dispatchers gather, by telephone, the reports for the preceding shift, thus completing the 24-hour reports shortly after midnight. After collecting his reports, the Load Dispatcher on duty reads them through and picks out all important items pertaining to operation, etc. and notes same, in pencil, on a blank Service Report form, using the proper sheet for the record. When all reports for the day have been collected, the Dispatcher on the 12:00 a. m. to 8:00 a. m. shift completes the checking and finishes the pencil copy. The complete report is then typewritten on the various sheets, using Hectograph typewriter ribbon, and nineteen copies made on a duplicator. These copies are mailed to the Head Office of the Company in time to arrive shortly after the engineers and officials are at their desks, and their value is such that any delay in completing or mailing results in a storm of protest.

It may be of interest to note that several methods of producing a report of this kind in quantity have been tried, and only two found successful to a degree. For several years the "Daily Service Report", or "Our Daily Newspaper," as it is sometimes called, was made up on onion skin paper and typewritten with standard black carbon paper. This method was successful with a limited number of copies, but with the growth of circulation, it was found impossible to produce more than ten reasonably legible copies, and the Hectograph was resorted to. At present this Company is using a medium weight white bond paper of good quality for the printed forms, and very good results are obtained up to about 40 copies.

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COMPANIES REPORTING

City of Tacoma (Municipal Plant)
Puget Sound Power & Light Co.
San Joaquin Light & Power Co.
Northwestern Electric Co.
Southern Sierras Power Co.
City of Los Angeles Bureau of Power and Light
Southern California Edison Co.
Portland Railway Light & Power Co.
Pacific Gas & Electric Co.

Long Range Weather Forecasting

BY E. A. BEALS
United States Weather Bureau

(Whether next winter will be wet or dry and to what extent, is a question which is difficult to answer, and the answer would be more or less a matter of opinion. It is a question which if it could be definitely answered would be of the greatest importance to the country as a whole, as it affects industries, agriculture, and the power companies. If it were possible for the power companies to know the amount of rainfall to expect in any season, they could draw upon their storage reservoirs with more accuracy than is at present possible. The subject of long range weather forecasting was discussed at length at a recent conclave of the Technical Committee of the Pacific Coast Division of the N. E. L. A. held in San Francisco. A resumé of three of these papers is given here in order to stimulate further research along these lines.—The Editor.)

The first thing to consider in making long-range rainfall predictions is the cause of rainfall, which is little understood by many otherwise well-informed persons. By the term rainfall, is meant precipitation in the form of rain, snow, or hail, and it is caused in three ways, one of which takes place when warm winds blow over a cold surface. In this case the temperature of the air is reduced in consequence of its proximity to the cold surface, and if its temperature becomes lower than the dew-point, condensation occurs.

This cloud and rain forming process in the Northern Hemisphere is most pronounced when the wind is south. At such times large quantities of warm and moist air are transported from the south over colder surfaces to the north, and thereby cooled below the dew-point. The surface winds are retarded by friction, consequently the movement is more rapid aloft than near the ground, which accounts for the condensation taking place between 2,000 and 10,000 feet in elevation rather than near the ground. The clouds thus formed are usually of the stratus or nimbus form.

Another rain-forming process is caused by convection, whereby heat is transferred by currents of ascending air. When the ground warms rapidly during the day, the air ascends and in doing so expands and becomes cooler. When the dew-point is passed the excess moisture forms into clouds of a cumulus character. These clouds are frequently extremely thick and should they become overgrown and vigorous enough, rain, hail, or both, will fall from them. Frequently cumulus clouds develop into electrical storms, especially in the upper Mississippi and Missouri valleys, where most of the summer rains are caused by this process. The precipitation in that section of the country is greatest in Summer and least in Winter solely on this account.

The third method of producing precipitation is where moist air is forced to rise in ascending a hill, mountain or other barrier, and likewise when forced to rise by an area of low barometric pressure. Clouds forced under the latter condition are of the stratus or nimbus variety. Rainfall on the Pacific Slope is due far more to this method than to either of

the others. We have the mountains up the sides of which the air is frequently forced to ascend, and when this ascension is accelerated by the presence of a low pressure area, we have abundant rains.

Low barometric pressure areas are variously designated as storms, or cyclones, and sometimes, especially when of slight energy, they are simply called LOWS. When very severe they are known as typhoons, hurricanes, et cetera. Their mechanism is practically the same by whatever name they are called. The difference between them is confined to the degree of their energy, the same as in steam engines, where one may be of only one horse-power and another be of several hundred horse-power.

Practically all of the low-pressure areas causing rain in the Pacific States are off-shoots from a large semi-permanent low-pressure area over the Aleutian Islands, which is persistent in that locality only during the colder months of the year. The differences in gravity between the two masses of air cause an ascending circulation within the low-pressure area over the water and a descending one within the surrounding high-pressure areas over the land.

Near the surface of the earth the air currents move into the low-pressure area over the water to take the place of the rising air, which after ascending to a sufficient height experiences gradients causing it to flow outwards toward the air which is contracting over the colder land. This circulation is further modified by the revolution of the earth on its axis, with the result that the winds flowing in toward the low-pressure area over the water are deflected, and we have a gigantic whirling mass of air with winds flowing spirally outwards and upwards in the neighborhood of the Aleutian Islands during the colder months of the year.

Off-shoots are frequently detached from the parent mass of revolving air over the Aleutian Islands. They move to the Pacific coast and thence inland, to greater or less distances, in accordance with their strength and character. Some are apparently too weak to cross the Rocky Mountains and they disappear or become so feeble as to be scarcely noticeable. Others move across the continent and in doing so gain or lose energy in accordance with the supply of heat and moisture received on their way to the Atlantic coast.

These off-shoots from the semi-permanent Aleutian low-pressure area are the real producers of the bulk of the rainfall in the Pacific States. The quantity and location of the precipitation depends upon their energy and the track they take in traveling across the country. When they are unusually energetic the precipitation is heavy and widespread. If they be feeble, the precipitation is light and confined to a small area. Between these extremes there is no limit to the gradations that may take place.

In order to predict where the rainfall is going to be most abundant, it is necessary to know the track the center of the disturbance will take in passing into and across the country. Should it enter British Columbia and thence travel an easterly course, no rain would fall in California unless the disturbance was of great magnitude, and even then it is probable that rain or snow would fall only in the extreme northern portion of that State. A storm moving eastward from British Columbia would cause copious rains in Washington and a somewhat less amount in Oregon.

Should the center of an off-shoot from the Aleutian low-pressure area appear off the Pacific Coast anywhere south of the mouth of the Columbia River and move southeast or east, the rainfall in California would be heavy, in Oregon light, and probably none would occur in Washington.

It has been noted by the forecasters in the Weather Bureau that when the barometric pressure is unusually high to the north of the Aleutian low and the high-pressure area over the ocean between San Francisco and Honolulu is in a weakened condition, the track of the rain-bearing disturbances visiting the Pacific States is farther south than when these conditions are reversed.

This year the barometer has been unusually high for long periods over northern Alaska, and the permanent high-pressure area over the ocean to the west of San Francisco has been below normal on numerous occasions. Consequently the storms from the neighborhood of the Aleutian Islands took a more southerly route and California has received an abundance of rain and snow.

The semi-permanent low-pressure area over the Aleutian Islands and the permanent high-pressure area off the coast of California are called "Centers of Action" by meteorologists.

It certainly would be worth while to investigate more closely the behavior of the Aleutian center of action, as the off-shoots coming from it cause the bulk of the rainfall experienced in the Pacific States. We now have three meteorological stations there; one at Dutch Harbor, another on the Pribilof Islands and the third at Kodiak. None of them has a full equipment of instruments and all the observational work is done by untrained observers.

There are two lines of investigation which are considered by many as being the most hopeful of leading to success in long-range weather forecasting. One is to connect the weather with the variations in the supply of heat from the sun and the other is to connect it with oceanic circulation. Much work has been done in both cases, but so far without practical results.

The maximum intensity of solar magnetic storms and the greatest rate of change in solar activity are believed to occur about two years after the sun-spot maxima.

The most recent correlation between sun-spots and weather was published a few months ago. In that article the astronomer, W. H. Pickering, claimed that in the last fifty years the Island of Jamaica experienced twelve droughts and nine of them followed closely after sun-spot maxima or minima. As there have been only ten sun-spot maxima and minima in the last fifty years, a drought must have occurred in every case except one. There were three that did not coincide with sun-spot frequency, therefore forecasts based upon sun-spot frequencies would result in one drought being predicted that failed to occur, and three would have occurred that were not predicted. The verifications, therefore, would be 69%, which is not bad.

An important point in predictions of this character is the time element. One would want to know just how closely after the sun-spot maxima and minima the droughts were due to take effect. We cannot predict exactly when the sun-spot maxima and minima will occur, and for this reason there is bound to be more or less uncertainty as to the time of its occurrence in making long-range predictions of this character.

The next matter to consider is whether or not a more thorough understanding of oceanic currents will be of service in this work.

The oceans are vast reservoirs of nearly ice-cold water. Their temperatures at depths of a few hundred fathoms range between 36° at the equator and 28° in the polar regions. When upwelling of cold water from below takes place, the air is chilled, and the winds are disturbed. Also in the Northern Hemisphere when warm surface currents flow from southern to northern waters the climate in northern areas under their influence is greatly modified.

The salient features connected with the problem of long-range rainfall predictions have been outlined, and though I cannot see any immediate prospect of success, I do believe the problem will eventually be solved, if not wholly, at least to such an extent as will answer the purpose of engineers and many others who are interested in this phase of weather forecasting.

INDICATIONS OF SEASONAL VARIATIONS OF WEATHER IN THE GROWTH OF RINGS OF TREES

BY A. E. DOUGLASS
Director of Stewart Observatory, University of Arizona

This work on tree rings, which I have been interested in for a great many years, is, you understand, a study that is not yet finished, and, as it were, I am giving you a sort of report on its present condition. It has involved in all these years the identification, that is, the dating, of over 100,000 tree rings and the measuring of the actual width of more than 100,000 rings in about 400 trees with groups in Oregon, California, Arizona, Colorado and Vermont, and a number of groups in North Europe, in several of the different countries. It has been applied, particularly in the last few years, comparatively few years, to the big Sequoias of California, so that it includes quite a number of them.

The disadvantages of using tree rings are several. I might mention one of the disadvantages is that we do not know exactly what the tree ring represents. I shall show you some indications in a few minutes that the rings represent something fairly tangible, that is, I will show you some of the relationships of tree rings to rainfall; but still the tree ring is a product probably of several different forces; it includes, perhaps, especially in the dry countries, chiefly rainfall, but it also includes temperature, and there is some reason to think that in places it includes some other factors that we have not yet gotten hold of. On the other hand, the age of the tree ring ought to give some idea of the amount of the precipitation. It would be pretty rough, but it could be worked out, I think, in time, so as to get more accurate results for the variation in the tree rings, and then you would have some idea of the variations in the amount of available water in any one particular district. Of course a great advantage in this study of tree rings, perhaps, as an indication of climate, is that it extends over an enormous period of time.

There was reference made a moment ago to the records of the Nile River—I forget exactly how far back those go, but I think it is less than a thousand years. Now, it is true that the tree rings in the yellow pine, on which I have done a large amount of work, go back only to 550 years, that is, in northern Arizona, and those are the ones I am at present working on. But the rings in the Sequoias up in the high altitudes go back 3225 years, and that is the one single tree that, so far as I know, is the oldest of any of the trees from which I have been able to get records.

The growth rings of trees in an ordinary cross-section may be roughly divided into three general types. First, the complacent rings, which show little or no variation from year to year. Trees growing in swamps or where they have a never-failing water supply are quite apt to be of this type. The second class are the sensitive trees, where there are variations from year to year, so that the rings have a marked and recognizable individuality. The third class is the erratic type such as is found in some of the yellow pines of Arizona, where the water supply is badly deficient.

The factor which is common to a large area of trees is climate, and variations of climate may be found in the trees. The best comparison which I have been able to make is between the trees at Prescott, Arizona, and the rainfall obtained at a station about a mile distant. The similarity is very striking, and when slight allowance is made for conservation of moisture, the accuracy with which the trees record the rainfall is about 85%. I cannot make as good a demonstration of the accuracy of the growth of sequoias, because the nearest rainfall station where long records have been obtained is sixty-five miles away, and 5,000 feet lower elevation, but there are indications of similarities and I am confident that if records could be obtained near to the big trees, they would be found to show a marked correlation.

There are two more advantages in using the records of trees. One is that they represent a perfectly natural response to climatic conditions of the type involved in crops, and that, therefore, they may integrate more perfectly than we know how to do the proper combination of climate elements. The second advantage is that they go back over great periods of time. The longest rainfall record which we have is that of Paris, which began in 1690.

But the tree records of the yellow pines in Arizona go back about 530 years, while the sequoias in the high California mountains carry it back 3,225 years.

The most important general statement derived from the study of cycles in trees that has as yet been made is that the sun-spot cycle or some of its multiples is nearly universal. It is not always the most prominent, but the larger the group and the longer time during which it can be studied, the more certain it is to appear.

The Periodograph

There are a good many different ways of trying out a series of measures with reference to periodic effects existing in them. This may be done mathematically by a Fournier series or it may be done by various harmonic analyzers. In 1898 Professor Schuster in England suggested a periodogram as a means of representing the intensity of different periods existing in a series of observations, as, for example, annual measures of the sun-spot numbers. In 1914 I constructed an instrument which would produce a periodogram automatically, just as a spectroscope produces a spectrum, but I was not satisfied with the periodogram since in a long series of observations there might be different periods succeeding each other. In the periodogram these are all merged together and may hide each other. So I constructed an instrument which would give me what I call a differential pattern, and yet the same instrument can give a periodogram. I have, therefore, called it a periodograph. In this instrument the light enters through a plotted curve, passes a mirror or two, and is reflected from a movable mirror running on a track so that the apparent distance of the curve may be greatly altered. A scale is attached to the side of the track and when the proper distance is found the period may be read off from the scale. In the instrument itself, the light from the mirror

passes through a cylindrical lense and is reduced to a system of parallel vertical bright lines, each bright line corresponding to a crest in the curve. These are allowed to fall on an analyzing plate consisting of parallel opaque lines, and a kind of interference is produced, making a set of horizontal fringes. A large amount of information may be read from the character of these fringes. The instrument can detect logarithmatic variations as well as simple periodic cycles. It has been applied to the solution of variable star periods with great success. By means of the pattern produced, not only is the mean period ascertained, but its variations and subdivisions are apparent. Where the period is constant it gives a straight fringe, but if the period varies the fringe bends one way or the other.

This instrument gives rapidly and efficiently the best solution of possible periods in a mixture having almost any degree of complexity. It is by this kind of solution that the general prevalence of the sun-spot period has been recognized. The existence of a period a little over two years or the half sun-spot cycle and of multiples of the sun-spot cycle, and of 100 years or more in length has been ascertained. By this, also, it is recognized in the great age of the yellow pines that the sun-spot cycle was operating 500 years ago, and in the sequoias it is found 3,000 years ago. By this instrument it also has become recognized that the different centuries in the last 3,000 years have been characterized by different combinations of short period cycles. The instrument is now being devoted to a study of these short periods with promising results.

I here show the rings on a beam taken from some of the old ruins of the cliff dwellers in Northwestern New Mexico and Northwestern Colorado. I am trying to take the circles in those beams and determine from them when they were living trees. If I can do that I will be able to tell when those dwellings were built around Flagstaff.

THE PROBLEM OF SEASONAL WEATHER FORECASTING

BY EDWARD H. BOWIE
United States Weather Bureau

The problem of making long period forecasts has for years received consideration from not only meteorologists of good repute—scientifically speaking—but from others not wholly scientific in their understanding of the question. A few, even, have entered this fascinating but elusive field of investigation for the purpose of personal gain rather than for the purpose of scientific accomplishment. There seems hardly any need to point to the works of the latter class, for out of their efforts nothing has been gained other than publicity. They have endeavored to connect weather changes far in advance with the moon and the planets, with the character of the weather of certain days as representative of what the weather will be during the succeeding month or season, etc., and have aided in building a type of superstition that the honest meteorologist has to combat at every turn. Such pseudo-scientists have been a distinct hindrance and not a help to the solving of the many difficult problems that have confronted the meteorologist of honest endeavor. Would you believe that one of them has based a scheme of weather forecasts for a season in advance on the activities of soil bacteria? It seems hardly possible that such a connection could be imagined, but the central bureau has the scheme on file and it is available to any one who may wish to pursue a similar line of investigation. This is but one of an untold number of schemes for weather forecasting on file in the central office; all of which are available for consideration by any one who may wish to waste his time in the reading of efforts—some of them earnest—to solve the problem of long range weather forecasting.

One naturally inquires as to why nothing really definite has been evolved that might be useful in long-range forecasting, and the only possible answer we can make is that the right combination has not yet been found. And this answer must be based on the supposition that these deviations from the normal obey some yet unknown law and are not entirely fortuitous; for if the latter, then all efforts to perfect a system of long-range forecasting must necessarily fail. I am not willing to admit that these deviations from the normal are entirely fortuitous and that efforts to solve the problem of long-range forecasting are on a par with efforts to solve the problem of perpetual motion. My opinion is that we have not yet acquired data covering a sufficient length of time to really get at the facts in the case. Possibly we are not studying sufficiently the data we already have or possibly some data that contain the clue from which a solution will be had. If we are looking for cycles, then admittedly the data do not extend over a sufficient number of years to permit of correct deductions. Records of the various meteorological elements for, say, fifty years are not sufficient. Records for 100 years might permit the drawing of inference, but the records of 200 to 300 years are probably necessary to develop the facts.

Assuming that the records are too short to satisfactorily develop possible periodicities, and, further assuming that none exist, where should we look for a possible solution of the problem? For example, we know that abnormally high pressure off the California coast and low or relatively low pressure over Alaska and the Aleutian Islands will give a minimum of rainfall in southern California, and that the seasons of plus deviation from the normal are associated with high pressure over the interior of Alaska, a southward extension of the semi-permanent winter low over the Aleutian Islands and at the same time a breaking down of the high pressure off the California coast. The inference is that under the latter condition the lower air strata in the eastern Pacific flows up the west coast of Mexico and gradually losing temperature and becoming supersaturated give the wished-for rains, while under the former condition, the winds off southern California are from the northwest and moving southward and becoming warmer depart more and more from a state of saturation.

Hence my opinion that a thorough study of the "Tendencies" of the general circulation over the Pacific Ocean and particularly the meteorological conditions over Asia during the months immediately preceding the beginning of the rainy season will lead to important conclusions concerning the plus and minus deviations from the normal rainfall in California. But sufficient data must be had on which to base this study. I doubt if such data are now available. Then, the thing to do is to outline means for their procurement. This will entail the gathering and compiling of observations from all points within and bordering on and from vessels sailing on the Pacific Ocean. A by no means small task, but it would, in my opinion, be worth while; moreover, this will be a step toward the preparation of daily, seasonal, and yearly charts of the atmospheric conditions of a world-wide nature. Perhaps when such charts become available for study purposes many of the problems confronting meteorology will be possible of solution.

Meeting the Demand for Retail Sales People

BY G. E. ARBOGAST AND F. E. BOYD

(Twenty years ago there was no such thing as an electrical household appliance. The rapidity with which these have become popular has created a demand for a highly developed sales organization in the retail field. The art of developing a sales force is treated in this paper submitted by the Commercial Committee to the Pacific Coast Section, N. E. L. A.—The Editor.)

Foreword

The phenomenal growth in the sale of electrical appliances of all kinds within the past two years has been due to, first, the sale of the electrical idea, second, the improvement in retail stores and third, the intensive campaigns in the sale of labor-saving electrical appliances. It is of the utmost importance that the interest of the central station, manufacturer, jobber, contractor-dealer and consuming public be considered in this study of retail sales people. In studying this problem it is conceded that the public needs, and will be greatly benefited by, the increased use of electrical appliances.

Selection

It is manifest that one of the most important things to consider when promoting the use of electrical appliances is the proper selection of the sales organization. The paramount thought before the employer, especially in the larger companies when he is looking for an office boy or apprentice, should be to employ the applicant who in his opinion could become a future general manager. Those whose business it is to sell should choose for their younger employes who occupy in the beginning minor positions people who will readily develop into material for salesmen. Whenever possible the more responsible positions should be filled within the organization by promotion.

There is nothing more encouraging to employes—more productive of loyalty and diligence—than the feeling that their work is appreciated, and that when a position of greater importance is to be filled they will be considered. In choosing an employe either from within the organization or from the outside, the following qualifications should be given careful consideration.

Aptitude.—It is of the greatest importance that the one selected for any particular work should be qualified for and adapted for it. Fitness of each employe for his work is essential to the efficient and effective conduct of a business. It develops in the employe confidence, encouragement, cheerfulness and efficiency while if he is not fitted to his work lack of confidence, discouragement, despair and inefficiency result.

Health.—Good health, a clear mind and plenty of surplus energy when well directed are magnets of trade and sales. The influence of health on disposition and personality is fully realized, as is also its influence on memory and clear thinking. Good health, optimism and cheerfulness tend to associate closely, and their relation to selling has been recognized. There is no calling in which the factor of good health and the external evidences of it such as good posture, lively steps, bright eyes and clear skin count for so much. One in this field of work who does not possess these qualities is handicapped from the start.

Appearance.—Personal appearance has much to do with the success of any business man and particularly with a salesman who comes directly in touch with the public. Consider how the salesman will impress his clients by his facial expression, his physique, his carriage, his clothing, neatness and cleanliness.

Address.—Consider voice, manner of speech—whether convincing or persuasive—ability to express himself clearly and briefly, quiet self confidence, courtesy, tact, enthusiasm and cheerfulness.

Courtesy.—Unless one's early training has given him that deep seated courtesy which emanates from the heart and permeates every action, or unless he has acquired this most important attribute he is at once disqualified as a salesman.

Honesty and Integrity.—These two qualifications go hand in hand and both terms express the one idea. An employe who will lie or steal for his employer will lie or steal from his employer. Apply the golden rule to your dealings with employes and they will practice it in their relation with your customers. No business can be built upon a firm foundation without absolute honesty in its dealings with its employes.

Loyalty.—No one can be a successful salesman or a satisfactory employe who is not at all times loyal to his company. This feeling can be fostered by proper consideration on behalf of the employer. If the employe cannot be loyal and true he should have no place in your organization.

Training

If sales people are selected from employes they will have had some of the early training in the right direction. If selected from the outside, experienced salesmen should be chosen. In either case personal contact between the management and employe should be brought about. Special means should be provided to give the salesman the knowledge he should have if he is to represent the organization intelligently. Some of the mediums which can be used are:

Regular Sales Meetings
Regular Sales Demonstrations
Regular Conferences with the Sales Manager

The sales manager's direction should be of such a character as to bring out the natural talents of the salesman.

Sell him your organization.— Every employe should be so thoroughly posted in the business he represents in its principles and ethics, what it stands for in the trade and in the community, what its aims and ideals are, that he feels himself a part of the organization. Cooperation between the sales force and every other branch of the organization is most vital.

Intimate knowledge of what he sells.—Before the salesman undertakes to sell appliances he must know their value and usefulness to the customer. He should know of what and how they are made, whether or not they can be repaired, and if so, what the cost will be; how they compare with competitive lines in price and efficiency, and the reason for any difference in price. He should never "knock" a competitor or his goods. If his competitor's product has points of superiority he should gracefully admit it, at the same time truthfully maintaining and explaining the meritorious points of his own product. Truth and frankness pay in the long run. In time the customer will surely find out if he has been deceived, and if so, confidence in both the salesman and his company will be destroyed.

Sell him the electrical idea.—The electrical idea is the fundamental which ties together the various branches of our industry. Our key note is "better service to the public" and

this should be the salesman's first thought. He should understand the function of each branch of the industry, and the correlation between his branch and the others. The more intimate his knowledge of the problems of the central station, manufacturer, and jobber, the greater will be his ability to serve the industry and the public.

Salesmen should study.—Every salesman should be encouraged to study scientific salesmanship, to read trade papers and to post himself as fully as possible in the details of his business. Opportunities too numerous to mention constantly offer to him a means of increasing his knowledge.

Compensation

A straight commission is theoretically, the ideal method of paying sales people, but in most retail stores is very difficult to carry out properly. Unless very carefully established it may lead to much friction among the employes. Some of them are likely to rush ahead of others in trying to get an opportunity to serve customers, others will try to avoid all other work, such as care of stock in order that they may be ready for customers at all times. Customers with small orders are likely to be neglected for those with large ones.

The combination of a straight wage and a commission is much more practicable and is recommended for the retail store. A minimum wage of fair proportion should be given plus a commission of a certain percentage, 2 or 2½%, of all sales made. This method if judicially applied not only offers a fair remuneration at all times, but creates as well an incentive for increased efforts.

Opportunity

Salesmanship is the foundation of most business success, and every employe should be made to feel that his future opportunities not only with his company but in the business world depend upon the success with which he handles that which is given him to do. In his own company this will be recognized by promotion, giving him a better field and better compensation. In large corporations he should be and often is given opportunities to buy company stock upon liberal terms, and if his firm is a co-partnership and not a corporation he should look forward to the time when he can become an active partner in the firm's business.

In addition to this he should be made to feel that as he increases in knowledge and usefulness his field is by no means limited to a narrow zone, but it is as broad as the industry itself, and that his present employer will take a personal pleasure in helping to boost him into the place of greater opportunity whenever he may outgrow his present position.

COMMITTEEMEN

G. E. Arbogast, Chairman, Charles S. Northcutt, E. B. Criddle, F. E. Boyd, Tracy Simpson, A. L. Spring, Frank Airy, Hugh Kimball, H. H. Courtwright.

The Convenience Outlet—Its Progress and Future

BY GARNETT YOUNG AND A. E. ROWE

(The electrical home idea has proved to be one of the most productive and educational of all the cooperative enterprises of the electrical industry in the West. The president of Garnett Young & Company, writing for the Commercial Committee, Pacific Coast Section N. E. L. A., summarizes for the 1921 convention the history and progress of this important movement, and its future possibilities.—The Editor.)

In the fall of 1919, a paper was prepared in Sub-Committee and later adopted and presented by the Commercial Committee, N. E. L. A., Pacific Section, which brought up for cooperative handling, by the united industry in California, the subject of complete wiring in the home. This paper, the title of which was, "How the Electrical Industry Should Cooperate with the Architect and Home Builder," made it perfectly clear that the future development of the domestic application of electricity rests chiefly upon a single contingent factor of economic bearing, i. e., convenient service to the consumer; further, that this desired element of convenience can be attained only through educating the public to an acquaintance with and liberal use of the flush receptacle as an outstanding feature of household wiring installations.

It was demonstrated that the responsibility for inadequate home wiring could not justly be laid to the architect and builder, but to the electrical industry itself, guilty of unsound sales propaganda, and that, in seeking a remedy, it is up to the industry to undo its own mischief and set the public straight; that in such an educational task the major efforts must be aimed direct to the people but supplemented, of course, by such assistance as might be obtained from architects, builders and other mediums. With these conclusions accepted as a foundation premise, the paper proceeded with specific suggestions as to attacking the problem which is after all to sell the electrical idea to the public, and the recommendations therein made were endorsed by the Executive Committee of the Pacific Coast Section, that authority in turn calling upon the California Electrical Cooperative Campaign to undertake the actual work of education. Thus, action was gotten under way many months before the appearance of the paper at the convention, Pasadena, May, 1920.

The Cooperative Campaign accepted the responsibility and started to work early in 1920, inviting to its meetings a number of individuals particularly interested. Enthusiasm was most marked and gave birth to several phrases that have since become famous. "An Outlet for Every Appliance" was the slogan adopted within the industry as most fittingly measuring the ambition of the movement and the movement itself was deemed to have uncovered a vital fundamental, namely, that the flush receptacle, in both the physical and commercial sense, is virtually the "neck of the bottle," through which must flow the current that provides home service, while, at the same time, constituting the connecting link between electricity and the billion dollars of trade for the manufacturer, jobber and retailer that follows in the wake of its domestic adaptation. "Convenience Outlet," possibly not a new term, was selected as the best and most appealing designation under which to put forward the flush receptacle to the public, and ever since, our home wiring drive has been known as the "Convenience Outlet" Campaign, with various forms of publicity playing up that phrase.

Among the first steps taken was the publication of the Commercial Committee paper in the Journal of Electricity and The Architect and Engineer, with suitable illustrations and wiring diagrams, reprints being distributed to all architects, builders, contractor-dealers, jobbers, manufacturers, etc.

In January, Mr. W. S. Price was employed as special representative to interview and interest architects and builders, beginning his duties February 1st, and pursuing them continuously ever since. It was not long before this representative found it necessary to extend his sphere to cover the realty people, engaged in sub-dividing tracts for new residences. To all of these allies in home construction, Mr. Price has undertaken to get over the electrical idea and to demonstrate the various angles of convenience and economy accruing to the consumer in consequence of such foresight as would provide, in the first place, for the proper wiring of

homes and, in the second place, sufficient screen porch or basement space to accomodate laundry equipment.

The Electrical Home Plan

Contact with a group of sub-dividers led to the happy inspiration of the "Modern Electrical Home," a rather expensive innovation, but easily justified by the potential possibilities for direct and effective publicity. This experiment was first tried out in San Francisco and with such signal success as to induce repetition in Oakland, Sacramento and Los Angeles, two homes having been displayed in the last named city. The figures, in detail, as to publicity obtained, its cost, and the wiring features for all these electrical homes are given in the accompanying table.

	Outlets			Visitors	Cost Adver.	
	Conv.	Total	Days Open		Elect.	Total
Los Angeles .....(1)	28	83	17	19,000	$1,150	$1,550
Los Angeles .....(2)	37	117	25	57,100	1,800	5,000
Oakland	38	106	18	30,000	1,100	3,300
San Francisco	37	110	17	20,000	1,400	5,000
Sacramento	27	84	16	10,000	550	1,100
				136,100	$6,000	$15,950

Totaling this tabulation, it is found that in the aggregate these "Homes" were inspected by approximately 136,000 visitors, and it cannot be doubted that substantial numbers of them were interested and not merely curious; it was also noted that the majority of these visitors were intelligent and well-to-do people, so it is inconceivable that this educational effort will not bear fruit. Our demonstrators in charge of the "Homes" endeavored to supply all visitors with copies of the attractive pamphlets and wiring diagrams, telling the story of "Electrical Home" service; the same demonstrators talking with the guests placed emphasis on the "Convenience Outlet" as the means to the accomplishment.

Totaling another column, we find that the advertising cost for all these "Homes" amounted to $15,950, of which the electrical industry contributed $6,000 and the other participating interests the balance. Here is a fine illustration of economy through cooperation with our allies. It should here be mentioned that the industry's part of this expense was not paid from the Campaign treasury, but by special contributions from manufacturers, jobbers, contractor-dealers and central stations, situated in the community in which the respective "Homes" were staged.

Advertising the Convenience Outlet

As a means of capitalizing on the electrical homes and giving greater impulse to the dissemination of their educational potentialities, the Campaign has arranged for a suitable film, portraying by picture and story the appeal of electrical home service, emphasizing the indispensable necessity of the "Convenience Outlet." This film is now being run in San Francisco and Los Angeles, with a prospect that similar arrangements may be completed in the smaller cities of the State. This is a most promising channel for getting the electrical idea before the public at large.

Another pretentious bid for general publicity, to follow close on the heels of the films, is a carefully prepared series of 8 feature stories, illustrating and describing all the various rooms of the "Modern Electrical Home." These stories all carry cuts of the "Convenience Outlet," which is depicted as the key to electrical home service. These stories are to appear weekly beginning April 10th, and will be run in 25 of the leading newspapers in the State. Needless to say, this recognition by the press is in consideration of a large volume of concurrent advertising by retailers and central stations, to be paid for by the advertisers themselves without cost to the Campaign.

Still another effort has recently been aimed at national publicity supporting the "Convenience Outlet," this taking the form of an appeal, backed by impressive facts and figures, made by the campaign to all electrical manufacturers indulging in national advertising, and asking that they invariably include in their copy a small cut of the "Convenience Outlet" and some reference thereto approximating the following:

"Provide Sufficient Convenience Outlets: Wire the Home Complete for the Convenient Use of Electrical Labor-Saving Appliances and Lighting."

If the Campaign agitates this proposal to a successful issue, it will mean the subject of the "Convenience Outlet" will be kept continually before the public through the medium of popular magazines.

Appealing to Contractor-Dealers

The Campaign has planned a drive to awaken and enlist the enthusiastic support of contractor-dealers to "Convenience Outlets," the appeal being founded on self interest. Based on the California Housing Commission's figures as to existing homes and homes in prospect, charts have been prepared, giving the figures for each local district, representing lost business to the contractor-dealers through insufficient wiring of old homes, also possible increased business from the proper wiring of new homes. This drive, started in April, is to be carried into 15 districts of the State. The results would be greatly facilitated if the field men in charge would arrange with the contractor-dealers in each locality for show-window demonstrations, contrasting the "Convenience Outlet" with the old method of connecting appliances to fixture arms. To bring out vividly the significance of the "Convenience Outlet," lithographed cards should be employed to inform the passers-by. The expediency of this suggestion rests in getting the contractor-dealer to do something while the field man is on the ground; it is not enough to sell the dealer theoretically, he must be started on his way to selling the public.

During the year, some 35,000 reprints of the small house wiring plans for a "Modern Electrical Home" were distributed within the industry and among its allies, every effort being made to get copies into the hands of wiremen employed by electrical contractors as well as draftsmen employed by architects. Moreover, these plans were published in leading newspapers. Enlarged black and white prints for framing were placed on display in the salesrooms of manufacturers, jobbers, contractor-dealers and central stations, also with builders' exchanges. Thus, everyone concerned with the construction of homes has been furnished this handy data for proper home wiring.

The foregoing covers the chief activities of the Campaign to date and in immediate prospect, in support of the "Convenience Outlet" but we are fully aware that the only real measure of progress is results. What then has been accomplished by all this expenditure of time, effort and money? Obviously, that is not a question we can fairly address to the Campaign headquarters, but one the industry must itself answer, and to its own satisfaction, if the program followed is to be vindicated and the work continued without interruption.

Increased Sales of Flush Receptacles

Since the vast majority of all "Convenience Outlets" involve the installation of a flush receptacle, it would appear that our nearest approach to an accurate check on the

success of the movement is to compare the sales of flush receptacles between given periods. Therefore, the various manufacturers of flush receptacles were asked to report the percentage of increase, during 1920 over 1919, in sales of this article within the State, the comparison to relate to quantities and not values. The results of this check follow:

One	manufacturer	reports	27%	increase
"	"	"	33%	"
"	"	"	35%	"
"	"	"	40%	"
"	"	"	41%	"

Measuring Progress

It is not practicable to state whether this is a satisfactory showing to all parties interested. Each manufacturer and jobber would naturally analyze the figures in the light of percentages representing increased sales of other devices not related to "Convenience Outlets," and by that means make due allowance for changed business conditions and other adjustment factors. At all events, this comparison is really premature because of the outstanding circumstance that all of the "Electrical Homes" were staged after June 15th, 1920, while the most successful one, i. e., the second Los Angeles "Home," was exhibited early in 1921. Moreover, the other major movement aimed to capitalize on these "Homes"—i. e., the films and the 8 serial stories for newspapers,—are to get under way respectively during March and April of the current year. Since the effect of all advertising is cumulative, we must in fairness wait until, at least, the end of 1921 before expecting a check like the above to reveal the real progress made with the public.

At the present moment, opinion is divided as to what improvement is noticeable in architects' specifications; on the other hand, it is certain that some of the most important of the building investors are giving recognition to the "Convenience Outlet" in the new homes under construction and projected. The Campaign headquarters reports a specific check made in the Westwood Park section of San Francisco by means of two surveys taken respectively in February and December 1920. The first survey showed an average of 2 "Convenience Outlets" installed in each new home, while the latter survey revealed the fact that houses then under construction averaged each from 5 to 7 "Convenience Outlets."

A Conception of Possibilities

When one examines into the possibilities for business in consequence of a full and free exploitation of the "Convenience Outlet," one is confronted with figures so amazing as to be incredible. We have the fastest growing State in the Union, and this continually augmenting population establishes the necessity for ever expanding housing facilities; our field, therefore, is assured. Study the California Housing Commission's figures, which have often been quoted and will be omitted here, and realize the millions of dollars in electrical wiring contracts and the tens of millions in electrical merchandise sales, inevitably ours if electricity is to solve the domestic service problem. Indeed, the possibilities for our industry through exploitation of the "Convenience Outlet" utterly dwarf the possibilities to be expected from any other kind of drive. Why play with dimes when we can deal with dollars?

Does this glimpse of our goal inspire us to unceasing action? Shall we consider the nature of the task confronting us? Until "Convenience Outlets" are known to all householders and by them considered indispensable to electrical home service; until every architect and builder subscribe to this view; until every wiring contractor and electrical dealer is helping and not hindering the program; until recognition reaches that stage when a properly wired house, or apartment, commands an unmistakable preference and premium over the other kind, until these things are accomplished our work of education is unfinished.

The realization of this dream depends utterly upon the continued cooperative handling of the problem by the united industry, all efforts being built around two fundamentals, economically and ethically sound:

First: The end in view shall be convenient service to the public.

Second: The means to that end shall be education.

For the Good of the Whole

In respect to the above recommendation for cooperative effort, this committee holds that the work is too great and too complex to be successfully carried on single-handed by any concern or faction. The public, likewise our allies, the architects and builders, will never accept as educational any individual aggressions, but will consider such moves selfish activities reflecting the pursuit of business without due regard for the ultimate consumer's interest. Moreover, the Commercial Committee deplores any attempt by any concern or group to "pinch in" unfairly for private advantage on any of our cooperative exploits intended to benefit all parties interested. Any fudging of this sort would most assuredly tend towards distrust and inharmony to a degree that would threaten our present cooperative line-up.

In respect to the ultimate object, "Convenient Service to the Public," it is essential that everyone in the industry, bar none, recognize that electrical appliances are not a convenience and will not remain permanently in service where the connection is by lamp socket or other makeshift. We have the authority of the Society for Electrical Development for the following:

In homes not equipped with "Convenience Outlets," appliances lying idle on shelves, 60%.

In homes provided with "Convenience Outlets," idle appliances only 3%.

These figures shut off argument and demonstrate that foresight, constructive building for the future, absolutely requires the industry to look first to the proper wiring of homes and afterwards to the introduction therein of electrical appliances and equipment. Remember that every housekeeper conveniently employing electricity becomes a permanent salesman for the industry, doubly valuable because not on the payroll. Do we want these boosters, or shall we take our chances with potential knockers?

Right here seems the proper place to report the verdict of the Campaign management on the electrical contractors of the group engaged in wiring of homes. It is reported that, notwithstanding these contractors are a part of our industry and that they, above all others within our ranks, are the beneficiaries of the "Convenience Outlet" drive, they do not cooperate to sell the idea to the public, but in very numerous cases positively hinder the movement. This seems incredible, but it is a condition of fact the Campaign has to contend with, and at the present writing, not much success is claimed in the effort to make this element responsive. It is unfortunate that home wiring has been to such a degree relegated to this type of operator, being almost entirely neglected by the substantial contractor-dealers whose attention is taken up with commercial and industrial wiring, coupled with merchandising. The situation is pretty bad when the small army of men engaged in house wiring are so busy beating each other to it that they cannot stop and listen to the self-interest story.

Recommendations

The Commercial Committee endorses the Cooperative Campaign's activities in support of the "Convenience Outlet," as hereinbefore reviewed, and recommends the same be continued until we have penetrated much nearer to our goal.

The Commercial Committee recommends that additional "Electrical Homes" be exhibited when and where the time and place seem propitious, some of these exhibitions to take the form of bungalows, modestly furnished, and reflecting the impression that electrical home service is within the reach of the masses, not merely the well-to-do.

The Commercial Committee recommends that the lesson of the "Electrical Homes" be perpetuated by means of moving pictures and newspaper publicity, etc., to whatever extent is compatible with the Campaign's financial resources.

Commercial Committee recommends that where building contractors or building investors are erecting properly wired homes, the Cooperative Campaign capitalize on this success by arranging for such houses to be conspicuously placarded with a notice readable from the street, about as follows:

"This House Is Equipped Throughout with 'Convenience Outlets' for Electrical Home Service."

This publicity may force the hand of other builders and subdividers.

The Commercial Committee recommends that the Cooperative Campaign agitate to a successful conclusion the appeal recently put up to manufacturers for a recognition of the "Convenience Outlet" in their copy appearing in magazines of national circulation. The thumb-nail sketches, heretofore employed in illustrating this Committee's papers on the subject, would be very effective bull's-eyes for this character of publicity.

The Commercial Committee recommends that the Cooperative Campaign add to its forces an additional man to divide with Mr. Price the field work incidental to exploiting the "Convenience Outlet." Our state is too large, and the number of architects, builders and subdividers too great, for one man to do justice to the situation thoroughly and continuously.

The Commercial Committee recommends that the Cooperative Campaign charge itself with the responsibility of regulating the advertising of central stations, electrical dealers and other retailers to the point that appliances and laundry equipment will invariably be illustrated with the cords plugged into "Convenience Outlets" and **no mention** whatever be made of possible lamp socket connection. This must be disposed of once and for all.

The Commercial Committee recommends that the Cooperative Campaign instruct its field men to oppose the screw base receptacle, particularly as to home use. Its contacts are exposed, hence dangerous to children; moreover, it is a companion to the socket and both are back numbers as appliance connections, hence hindrances to the "Convenience Outlet" idea. The modern receptacle of the concealed contact type, installed on separate circuits, is the safe and up-to-date method of supplying electrical home service. This is the "Convenience Outlet" way.

The Commercial Committee recommends that the Cooperative Campaign grapple with the problem of the house-wiring contractor, hereinbefore discussed. It is perhaps the biggest obstacle to our progress, for it constitutes mutiny within our ranks. Every available means to educate and line up these recalcitrants should be employed even if it ultimately comes down to the expensive procedure of individual attention and follow-up in every specific case. We cannot, at this juncture, say the task is hopeless. Remember the former status of the electrical dealer with his hole in the wall; education developed him into a merchant with a store, salesmen, etc., a credit to the industry. A partial solution may be possible through the Campaign inducing the real contractor-dealers, who are business men, to enter into this house wiring game on a big scale with special departments that would capitalize on the immense publicity devoted to adequate outlets under the present movement.

The Commercial Committee recommends that the Cooperative Campaign have its field men follow up the public schools and colleges within the state, practically all of which have departments of household science, and see to it that their class kitchens and sewing rooms are served with "Convenience Outlets" to accommodate electrical appliances; where red tape stands in the way of prompt action in these institutions, it would almost pay the industry to have the "Convenience Outlets" installed free, for such facility would undoubtedly lead to a speedy conversion of these departments to the basis of doing it electrically. These thousands of students are the future housekeepers of the state and the industry should not lose this opportunity to have them taught the convenience and economic value of electrical home service.

The Commercial Committee recommends that the Speakers' Bureau plan under contemplation give due recognition to "Convenience Outlets," exploiting the subject before such institutions as schools and colleges with domestic science departments, women's clubs, particularly the Housewives' League, architect societies, builders' exchanges and the various electrical organizations, such as the State Electrical Contractors and Dealers, Pacific Coast Section, N. E. L. A., the Pacific Division, E. S. J. A., The Electrical Development League of San Francisco, and The Electric Club of Los Angeles. Do you ask why we specify these organizations within the industry as audiences for these lectures? Well, it is because 80% at least of the individuals gaining their livelihood from the electrical industry do not know what is going on concerning "Convenience Outlets" and, therefore, are blissfully innocent of the part they should play. The Speakers' Bureau can greatly stimulate the movement by posting, enthusing and coaching all of these people into an army of boosters. Suppose that 5,000 of these men in the rank and file throughout the state could be enlisted each to take the opportunity on some convenient Saturday or Sunday to call at the nearest residential tract and inspect a house or two in the guise of a prospective buyer; during such inspection, expressing surprise and disappointment that the premises are not wired with sufficient outlets to conveniently accommodate their floor lamp, heaters, table devices and laundry equipment, and intimating that because of these omissions, the house does not appeal to them. Now, suppose that the wives of these 5,000 men repeated the performance a little later. Can you imagine the effect on the tract salesmen—consternation! And forthwith these stampeded salesmen would sell "Convenience Outlets" to the builders as a necessity. This illustrates the dormant powers within the industry; and these the Speakers' Bureau may stir into action.

USE OF ELECTRICAL HOUSEHOLD APPLIANCES IN CANADA

Even in communities where the greater number of homes are wired for electricity, the percentage having an adequate supply of electrical conveniences is comparatively low. This is largely due to the nature of the wiring, the absence of convenience outlets tending to discourage extensive or frequent use of electric appliances.

A magazine recently sent out a questionnaire to every town and city in Canada where electric current was available, and received replies from more than 250, slightly more than one-third of the total. The report as given below shows that a large percentage of the houses built are wired for electricity, but the number of electrical devices used shows a large field yet to be covered.

The figures compiled from the questionnaire are as follows: Houses wired—74.9 per cent. Degree of saturation of wired homes—electric ranges, 3.1 per cent; electric percolators, 3.7 per cent; electric vacuum cleaners, 3 per cent; electric washing machines, 5.9 per cent; electric dishwashers, .07 per cent; electric water heaters, 1.3 per cent; electric toasters, 18.2 per cent; electric air heaters, 4.8 per cent; sewing machine motors, 1.2 per cent; electric irons, 45.7 per cent; electric ironing machines, 1.4 per cent; electric refrigerators, .06 per cent; electric fans, 5.4 per cent.

Figures showing building activity and comparative costs are interesting in connection with the house-wiring question. Building permits issued in 35 Canadian cities having a minimum population of 15,000 showed the estimated cost of building work during 1920 to be $100,679,839, as compared with $77,113,413 in 1919; an increase of $23,566,426, or 30.5 per cent. As in 1919, however, these figures must be interpreted in the light of increased cost of building materials and wages, although the last two months of the year showed some reductions along these lines. Taking 1917 as a typical year, when the figures were $33,936,426, the figures for 1919 and 1920 appear large, but when it is seen that in 1913 building permits amounted to $153,662,842, it will be noted that building operations in 1920, despite high prices of wages and materials, are still far behind those of years immediately before the war.

INDUSTRIAL ELECTRICAL HEATING

Appendix "A"

(Continued from page 488)

tasteless oil of a paraffin base. The hot oil coagulates the albumen in contact with the shell, hermetically sealing the shell.

During the past year, an electric machine, capable of preserving, by the above method, 48 dozen eggs per minute, or 34,560 eggs per hour, has been constructed and put into successful operation. Upon investigation it was found that it required 1.46 B.t.u. per egg to preserve the same; in other words, it would require 11.87 kw-hr. to preserve 34,560 eggs per hour. In order that the machine have sufficient reserve energy it was decided to construct a tank 5 feet long, 2 feet wide and 12 inches high. To bring this bath of oil up to temperature in 20 minutes, it required a total of 24 kw. of electrical energy.

The specification required that the temperature be maintained between 258 and 260° F. This was accomplished very accurately by means of an immersion thermostat. It was found that a temperature slightly above 260° F. resulted in serious cracking of the shells of the eggs by expansion, while a temperature below 255° F. did not accomplish the desired results.

Appendix "B"

REGULATING HUMIDITY ELECTRICALLY

Delicate Automatic Control Solves Problem of Securing High Efficiency from Box Drying Room

A western manufacturing company in drying boxes found that the wood had to be protected from sudden humidity changes while being dried or stored, in order to prevent checking and distortion.

In conducting the humidity experiment, it was noted that it is practical to raise the temperature for the purpose of lowering the humidity but impracticable to lower the temperature in order to raise the humidity. When an increase in the relative humidity is desired, it becomes necessary to add moisture to the air. After some experiment, it was found that constant humidity of 55% was best for drying and storage purposes.

In preliminary studies of weather conditions at the plant it was found that the humidity often varies from 40 to 100% in 24 hours. In fact, with a sudden change of wind the humidity at times varies 30% in one hour. Electric heaters controlling the temperature could be found for cutting the heaters in or out automatically as required by humidity changes.

Human hair was selected as the material most sensitive to changes of humidity without being considerably affected by temperature changes. Before being used in the instrument the hair is treated so as to remove any oil present and from time to time while in service it is removed from the instrument and cleaned, so that the dust does not clog the pores in which the presence of moisture causes expansion.

A dry room equipped with an electrically controlled device of this sort has now been successfully operated for a year and definite statements of results can be made. The room used for this purpose is 111 x 40 feet in plan with a mean ceiling height of 10 feet and is located on a dock above the water, one wall being exposed to the outside air. The floor is tight and the roof and ceiling are sheeted with roofing paper and made practically air tight. It is required that the humidity in this room be held at 55% and in order to do this under the most adverse weather conditions, a heater with a capacity of 33 kilowatts is used.

Three very sensitive hydrostats are located along the center line of the room at the quarter, half and three quarter points respectively. These hydrostats actuate two electrical contacts which energize a relay on the control board. The relay, in turn, energizes one of the double pole magnetic contactors, so that each contact controls a section of the heaters totaling 2.5 kw. in capacity. Twenty-two 1500-watt electric heaters are used, these being especially designed for 3-phase, 125-volt operation.

On sunny afternoons about 3 o'clock, two contactors representing about 10 kw. are sufficient to hold the humidity in the room at 55%. Between 3 and 5 o'clock a quick change in outside conditions usually occurs so that the humidity increases to perhaps 90%. The tendency of the humidity in the room to do likewise usually causes from one to four contacts to cut in during the later afternoon hours. Earlier in the evening there is usually a decrease in the amount of current required to keep the humidity as desired.

The following table is a typical weekly report compiled from regular readings of the thermometer hydrostat records. It is to be noted that the humidity variation is maintained within 1% in either direction from the specified standard of 55%.

Date	Time	Temperature	Humidity
11/16/16	9 a.m.	75	55
	12 m.	78	55
	3 p.m.	81	54
	6 p.m.	77	56
	8 p.m.	75	55
	12 p.m.	75	55
	3 a.m.	73	55
	6 a.m.	71	55
11/17/16	9 a.m.	69	55
	12 m.	74	55
	3 p.m.	77	55
	6 p.m.	77	55
	9 p.m.	76	55
	12 p.m.	76	55
	3 a.m.	73	55
	6 a.m.	70	56
11/18/16	9 a.m.	70	55
	12 m.	75	55
	3 p.m.	77	55
	6 p.m.	77	55
	9 p.m.	76	55
	12 p m.	74	55
	3 a.m.	70	55
	6 a.m.	68	56

The success of the installation at this plant, it is pointed out, should develop interest in the electrical method of the humidity control because of its notable adaptability to industries where humidity regulation is important. For example, in large color printing establishments where it is essential there should be no change in the paper that various colors may coordinate, and in leather and tobacco factories there is the same need for maintaining constant humidity.

Appendix "C"

BIOLOGICAL LABORATORY APPLICATION

A small but interesting installation requiring precision in temperature control is that of the Biological Laboratory in West Berkeley, producing high grade vaccine and antitoxins. The bacteria is grown on specially prepared jelly-like broth within glass containers, placed in the incubator room which is held at the constant temperature of 37.5° C. or 99.5° F.

The incubator rooms of which there are six in this laboratory are 8 feet long, 6 feet wide and 7 feet high. The walls are insulated between the joints with sawdust. There is one door which is insulated and made to fit tight. Shelves are placed around the room about 12 inches wide and 12 inches between each shelf. These shelves are perforated allowing the air current to pass through. There are four 750-watt wall type air heaters used in each room located two on each side wall. These heaters are wound in three sections and connect to two multiple contact thermostats, one on each side wall about 4½ feet from the floor. There are no relays or contactors used with these thermostats. The mean temperature in this room does not vary one degree Fahr. except when the door is opened. Each electric heater has 4½ square feet radiation surface and the heater does not operate very much above the temperature of the room. The power required for each room, operating continuously varies between 750 and 1000 kw-hr. per month.

The above laboratory also has in operation two pasteurization baths, capable of pasteurizing 72 liters of material at once with 12 kw. of electrical heat, installed in 1500-watt immersion heating units, controlled by four multiple contact thermostats. These baths are filled with water which is raised to 60° C. and the material placed in the water in six liter flasks. These baths have to operate within ½ degree C. and yet be capable of repeated heating and cooling. Under these severe conditions it has been found necessary to adjust the thermostats about every six months.

Appendix "D"

AUTOMATIC ELECTRIC ENAMELING OVEN

The cleanliness of electricity as a fuel is a recognized virtue. An even greater advantage of electricity over fuels in general, is the reliability of service and its unvarying heat value at definite adjustments, together with the simple means of controlling the temperature to be maintained as well as the duration of the cycle. This cycle of operation is as follows:

The oven being cold, at the start, the thermostat will make contact on the low position. The door switch and push button station are closed, the control being completed through the low contact of the thermostat, energizing the control relay which in turn closes the 3-pole magnet switch, or main contactor, furnishing power to the heaters.

The oven temperature rising, the thermostat will leave its low position, the 3-pole magnet switch, controlling the oven heaters being "held in" through a mechanical interlock on the control relay. The thermostat, on reaching the high position, short circuits the control relay, de-energizing the 3-pole magnet switch, thereby cutting off the power from the oven heaters. The oven, on again reaching its low or minimum temperature, repeats the above cycle.

It was found necessary and beneficial to have the duration of the bake under automatic time control. The control circuits of both ovens have been so connected with reference to this time switch, that the operator may put under time control either one or both ends of the oven simultaneously **with heat barrier in position**; or both ends operated in unison **with heat barrier removed.** This scheme of operation permits these people to fill their ovens ready for a bake, before closing their shop, the time clock starting and stopping the bake during the night or early morning, the material being thoroughly baked and ready to be taken from the oven when the workmen arrive the next morning. Putting through a bake between closing time of one day and opening time the next morning **is a saving of 100% of labor** during the cycle of that particular bake.

Another labor saver, other than the time clock, is the electric control thermostat, or in this particular case, thermostats which vigilantly keep the temperature of the ovens at a predetermined value.

Determining the proper baking temperature and duration of bake for every color and type of enamel used in their process, has enabled the Forderer Cornice Works of San Francisco, with the aid of perfect temperature and time control, to turn out uniformly finished material. "Spoilage" is a term unknown to this concern.

That the operating characteristics of this installation may be fully understood, the following conditions under which the oven is operated, are listed:

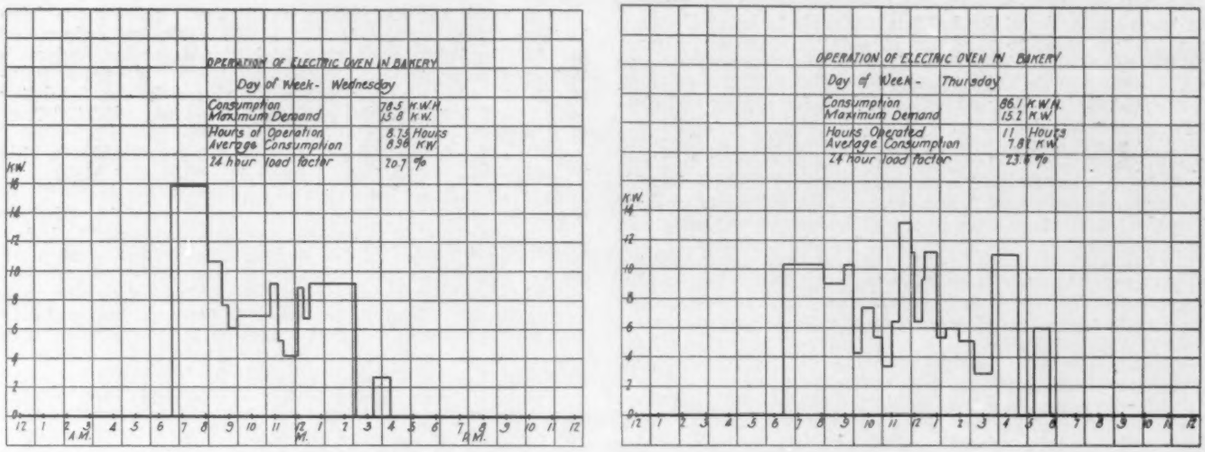
Oven 8 ft. high by 10 ft. wide by 22 ft. long.
Automatic time, temperature and ventilation control.
Power service, 220-volt, 2-phase, 60-cycle.
Connected capacity, 73.6 kw.
Initial temperature, 50° F.
Final temperature, 200° F.

A bake of 4000 pounds consisting chiefly of hollow steel doors, was placed in the oven, with heat insulating barriers removed. The results of this particular bake were as follows:

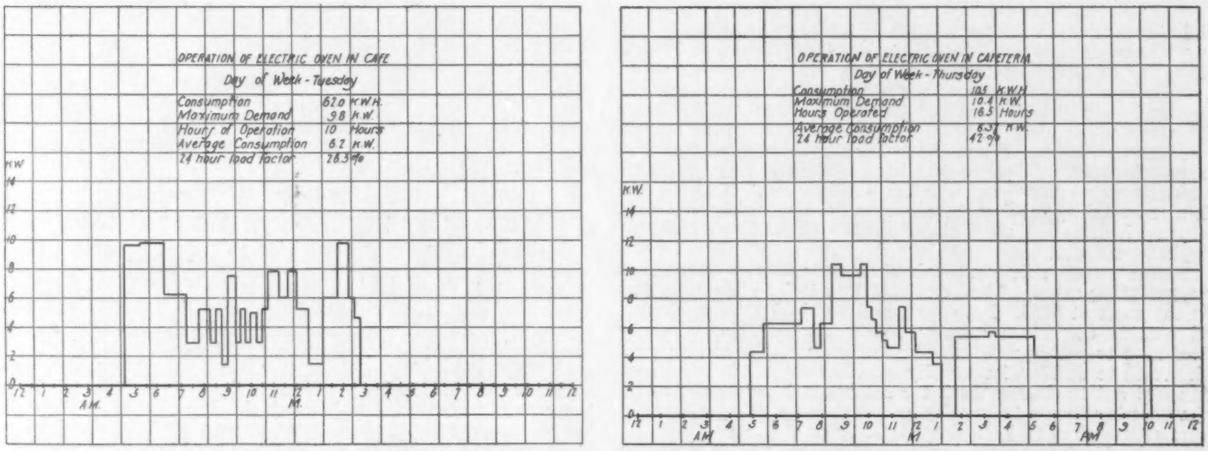
Load, 4,000 pounds, hollow steel doors.
Room temperature, 47° F.
Temperature of ovens at end of bake, 200° F.
Time required to reach maximum temperature (200°), 35 minutes.
Time oven held at constant temperature (200°), 3 hours.
Apparent or kva. capacity installed (V x I x 1000), 70.2 kw.
Actual kw. capacity installed (watthour meter), 69.82 kw.
Power factor of heaters $\frac{69.82}{70.2}$, 98½

Power consumed for entire bake (by watthour meter), 100 kw-hr.
Power consumed for entire bake (from graphic record), 100.19 kw-hr.
4,000 pounds metal baked.
100 kw-hr. consumed in baking.
Cost per pound of metal baked $\frac{100 \text{ kw-hr.}}{4000 \text{ lbs.}}$, .025 kw-hr.

Appendix "E"


OPERATION OF ELECTRIC OVEN IN BAKERY
Day of Week - Wednesday
Consumption 78.5 K.W.H.
Maximum Demand 13.8 K.W.
Hours of Operation 8.75 Hours
Average Consumption 8.96 K.W.
24 hour load factor 20.7 %
OPERATION OF ELECTRIC OVEN IN BAKERY
Day of Week - Thursday
Consumption 86.1 K.W.H.
Maximum Demand 15.2 K.W.
Hours Operated 11 Hours
Average Consumption 7.81 K.W.
24 hour load factor 23.6 %
KW.

Curves showing operation of electric ovens in two bakeries


OPERATION OF ELECTRIC OVEN IN CAFE
Day of Week - Tuesday
Consumption 62.0 K.W.H.
Maximum Demand 9.8 K.W.
Hours of Operation 10 Hours
Average Consumption 6.2 K.W.
24 hour load factor 28.3%
OPERATION OF ELECTRIC OVEN IN CAFETERIA
Day of Week - Thursday
Consumption 185 K.W.H.
Maximum Demand 10.4 K.W.
Hours Operated 16.5 Hours
Average Consumption 8.37 K.W.
24 hour load factor 42.9%
KW.

Curves showing operation of electric ovens in a cafe and a cafeteria

Appendix "F"

The most interesting electric furnace installation is to be found at the U. S. Mint, San Francisco. Due to the accurate test records kept on this furnace, it has been possible to make direct comparison between operating costs of copper and nickel melting, with oil as compared with electricity.

This electric furnace is a 1,000-pound Rennerfelt, being operated on 110 volts, 2-phase service.

The lining of the furnace is of silica brick, which has been known to run 1700 heats without being changed. The roof of the furnace is subjected to the highest heat, and requires changing more often.

(The following data is compiled on the basis of a sixteen-hour day.)

There are eight heats obtained per day, the first taking approximately two hours (cold start); the remaining heats for the day averaging one hour and forty-five minutes. The first melt consumes approximately 350 kw-hr. and the remaining seven about 275 kw-hr.

The furnace is controlled manually.

Copper is run at approximately 2600° F. while nickel is melted at approximately 3200° F.

Eighty-nine hundred pounds of copper are melted daily in the electric furnace. The same complement of men handled and melted 5500 pounds of copper in the oil-burning, crucible type furnaces, or an increased production of 3400 pounds of finished ingots in favor of the electric furnace.

The cost per ton in operating the electric furnace is $6.89 as compared with $9.84 in operating the oil crucibles, or a saving of $2.95 per ton.

To produce 4100 pounds of nickel ingots the amount of oil required in a crucible furnace is 4-4/5 bbls. and 1-2/3 crucibles, while the current consumed in the electric furnace for a production of 6900 pounds of finished ingots is 1900 kw-hr. and 10.7 pounds of electrodes, or a cost per ton for the metal melted electrically of $10.27 comparing with a cost per ton of metal melted in the oil burning crucible furnace of $14.49, making a saving of $4.22 per ton and an increased production of 2800 pounds.

From the above it will be noted that the electric furnace will handle a larger melt, with the same labor employed in operating the oil burning crucibles. Further, taking into consideration the depreciation of crucibles and the burning of electrodes, together with electric and oil consumption, the electric furnace has a lower operating cost than the oil burning crucible.

Appendix "G"

USE OF ELECTRIC FURNACE IN ENAMELING OF SANITARY WARE

In the enameling of cast iron ware, the ware comes from the factory to the sand blast department where it is chopped of rough spots and sand blasted. It is then brought into the enameling room, where it is painted with a so-called "slush coat" consisting primarily of China Clay and water, allowed to dry, and then placed in the muffle furnace and heated to a temperature of about 1500° F., which requires about six or seven minutes. The piece is then withdrawn, and the enamel, which is in a powdered form, sprinkled on by an operator from a sieve-like container. The piece is then again placed in the muffle and heated to a temperature of about 1500° F. where the enamel fluxes and forms a smooth surface. It is withdrawn again and the above process repeated, and then again heated, withdrawn again and inspected, and set aside to cool. The piece is then in a finished condition.

In the past, it has been the practice of heating cast iron sanitary ware in a closed muffled furnace. On the Pacific Coast fuel oil is used to heat the furnaces. It is necessary in this enameling process to bring the temperature of the interior of the muffle to a temperature of 1650 to 1750° F. With an oil fire, the flame passes under the floor to the muffle and up around the side walls into a flue which extends along the top of the arch. The fire box temperature of course has to be maintained at a rather high temperature, so that the heat will flow through the fire brick muffle, which is constructed of so-called cup brick. The temperature in the fire box very often reaches 3000° F. Of course in such a furnace the brick work in the muffle and fire box lasts but a comparatively short time. It is a common practice to replace the floor in this muffle about once every six weeks. It has been the practice in one particular plant to re-brick the entire muffle and body every fifteen months. The very high depreciation on this type of furnace, compared with the present high oil cost, encouraged this concern to investigate the possibilities of heating a muffle of this type electrically.

An electric test furnace has been installed and in operation for a period of two months, of which the following is a brief outline:

The interior of the electrical muffle wall is 11 feet long, five feet wide, and 18 inches to the spring of the arch, and four feet four inches to the top of the arch. The electrical elements extend across the floor, up the side, and around the arch. About 90% of the heating elements are exposed within the muffle, that is, they radiate directly into the muffle. The elements have been so arranged that with the muffle operating at 1650° it is possible to operate the elements at a temperature of 1750°, a condition which is absolutely necessary for long life of the electrical resistors in operating in a muffle held at such a temperature.

The fact that the electrical elements are directly in the muffle eliminates the high temperature gradient from the fire box into the muffle. There is no part of this muffle above 1750°. There is no reason why the brick work exterior of the muffle should not last a period of years. In other words, the depreciation on the brick work has been practically eliminated.

The above furnace is operated for twenty-four hours per day; the electric load consists of 160 kw., capable of being operated at 200 kw. should the occasion demand. In practice this muffle operates at a power input of 125 kw. per hour. This furnace is fed from a transformer whose secondary voltage may be varied between 40 and 80 volts, in 10-volt steps, and it is designed to operate with an automatic temperature control. The power factor of this installation is 97%; the load factor under normal operating conditions varies between 80 and 90%. With the above load factor, there has been a 20% reduction in the operating cost of the electric furnace over the oil fired furnace. This may be cut down to 25% when the above furnace is thoroughly insulated against heat loss.

The rejections of material enameled in the electrically operated furnace has been cut from 25% to 5%. As a whole, this electric furnace has worked out very satisfactorily, both from the cost and operating standpoint, and has found favor with both the management and the operators of the plant.

COMMITTEE

A. E. Holloway, H. L. Garbutt, J. H. Cunningham, W. W. Shuhaw, L. N. Hardie.

OVERCOMING SNOW TROUBLES ON ELECTRIFIED RAILWAYS

The Chicago, Milwaukee & St. Paul Railway has adopted a snow-proof motor housing that was developed on the London & Port Stanley Railway. The London & Port Stanley Railway passenger cars are equipped with ventilated type motors through which a current of air is drawn in operation. The motors developed trouble each winter, due to the melting of snow on the armatures. The crippling of motors became such a serious problem that immediate steps were necessary to eliminate the trouble. Accordingly, there was devised galvanized iron housings to enclose the vents through which the snow entered. It ended the old trouble and produced no new ones, as winter temperatures furnished all the cooling required. The test was followed with interest by the manufacturers of the motors and the idea, as stated, has now been passed along to the St. Paul electrification, where an identical problem had been encountered.

In mountainous country the problem of snowed-up lines is frequently a serious one, and previous to its electrification the L. & P. S. railway was occasionally stormbound for the better part of a week. Since its electrification, however, it has operated successfully through the most severe snow storms.

The principal snow fighting equipment is an ordinary steel nose plow, driven by an 800-hp., 60-ton locomotive. During the first couple of winters it was the practice to attach a plow directly to the locomotive. That entailed about three hours' work, the attendant delay, and the withdrawal of the motor service while the work was performed. Now nose plows are attached to each end of a flat car, weighted with 30 tons of rails. The car springs are removed to eliminate a tendency to climb.

Problem Course in Electricity

BY H. H. BLISS

(Why can you not get out of your battery as many ampere-hours as you put into it? What difference does the rapidity of discharge make to the number of ampere-hours obtainable? In the following article, the twentieth of a series, the author describes the methods of battery charging and the conditions affecting the charge.—The Editor.)

BATTERY CHARGING

Control of Current.—Storage batteries are generally charged by means of continuous current (direct current), which is forced through them in opposition to the voltage generated in the cells themselves. The applied pressure must then be somewhat greater than the battery voltage, for it must in addition overcome the internal resistance of the cells; the amount of excess over battery voltage is readily computed as equal to the product of amperes of charging current times battery resistance.

Accordingly the voltage applied to a lead battery must be regulated to approximately 2.3 times the number of cells. If a special generator is used in a charging station, the voltage is easily regulated by means of the shunt field rheostat. If direct current from a light or power circuit is used, it is generally necessary to put resistance in series with the battery; the ohms are varied until the ammeter in the circuit indicates the proper current.

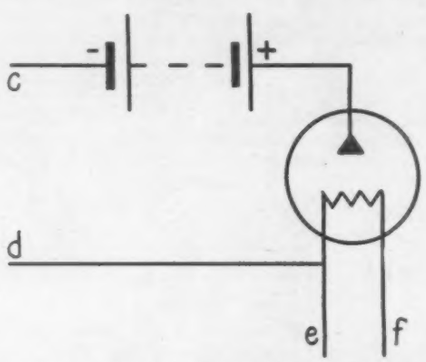


Fig. A.—Diagram of connections for charging a storage battery from an a.c. line by means of the tungar rectifier.

The strength of the charging current should be proportioned to the size of the battery. A common rule for lead batteries is to use from 6 to 10 amperes for each square foot of surface on all the positive plates in one cell, dropping to a lower current toward the end of the charge.

As a precaution, a "reverse current relay" is often installed in connection with a charging set. A typical "cut-out" of this kind contains an electromagnet excited by a coil of fine wire connected across the line; a second coil of coarse wire on the same core is in series with the battery. The armature of the magnet serves as a switch to connect the battery to the generator; if the voltage of the line drops below that of the battery and a reverse current starts to flow, the series coil opposes the shunt coil and destroys the magnetism of the core. The armature is then pulled back by a spring and the circuit between the line and the battery is broken.

Using Alternating Current.—It is frequently necessary to take current from a.c. circuits for battery charging. This current would discharge a battery during every alternate half-cycle unless "rectified" or made to flow in one direction only. The commutator used on an ordinary d.c. generator is an example of a rectifier; for battery charging there are on the market a number of other ingenious devices.

One of the most interesting of these is the "tungar" rectifier, illustrated in Fig. A. It consists of a bulb filled with rarefied argon gas in which are a hot tungsten filament and a solid graphite or tungsten anode. A wire sealed through the glass connects the anode to the positive terminal of the battery; other wires (**e** and **f**) passing through the base connect the filament to an independent source of current (a small transformer) which keeps the filament white hot. When wires **c** and **d** are connected to an a.c. power line, it is found that current can flow in only one direction, charging the battery during one half-cycle and stopping during the other. The explanation is that while wire **d** is negative the gas in the bulb is "ionized" and thus made a conductor by the negative "electrons" emitted by the filament; when **d** becomes positive the filament ceases to send out electrons and the gas ceases to conduct the current.

The mercury arc rectifier consists of a large glass bulb with a pool of mercury in the bottom. One wire, sealed through the glass, connects the mercury with the positive terminal of a battery, of which the negative terminal is connected to the neutral of a three-wire source of alternating current. The two outer wires from this source connect to electrodes in the upper part of the bulb. Current flows only **from** the mercury vapor in the bulb **to** the liquid at the bottom, and hence it flows downward from the two electrodes alternately, and from the liquid continuously into the battery.

The "electrolytic" rectifier consists of lead and aluminum electrodes in a solution of ammonium phosphate. Such a cell permits current to flow from the lead to the aluminum but not in the other direction.

Of mechanical devices for rectification, the vibrating rectifier, one form of which is illustrated in Fig. B., is the simplest. The horseshoe shaped permanent magnet polarizes the vibrator, **v**, so that it is alternately attracted and repelled by the electromagnet. The vibrator thus acts as a relay to close the circuit through the battery whenever the voltage is directed properly for charging.

For large scale work a motor-generator set is generally used, as being the most efficient and reli-

able apparatus. In some cases application is made of the "synchronous converter," a dynamo machine with a stationary field and revolving armature which has slip rings at one end and a commutator at the other. It runs as a synchronous motor and produces a steady direct current from the commutator.

Hydrometers.—The best indication of the state of charge or discharge of a lead battery is the density of the electrolyte. This is tested by means of the "hydrometer," a small hollow glass float with a graduated stem, which is enclosed in a glass syringe. When a small amount of solution is drawn into the syringe, the hydrometer floats with more or less of its top out of the liquid. In a fully charged cell the electrolyte contains more sulphuric acid than does that in a discharged cell, and hence is denser or "heavier" than when the cell is discharged and the acid weak. Therefore the higher the hydrometer floats, the more nearly charged is the battery. A reading of 1.29 (meaning that a pint of electrolyte weighs 1.29 times as much as a pint of water) is the indication of full charge for some cells; others are worked at a lower density and are fully charged at a reading of 1.23.

Another indicator of the state of a battery is the "ampere-hour meter," which is occasionally used. This instrument, somewhat similar to the watt-hour meter found in every residence receiving metered electric service, reads forward while the charging current is flowing, and backward while the battery is discharging. By properly arranging the gearing, the meter is able to take account of the losses of the battery, so that a reading of zero indicates fairly accurately the exhaustion of the charge.

Battery Losses.—As suggested above, we never get as many ampere-hours out of a storage battery as were put in to charge it. With both lead and nickel-iron cells the average "ampere-hour efficiency" (which equals ampere-hours given out ÷ ampere-hours required to bring the cell back to the original condition) varies from below 70 to about 90 per cent. The more rapidly the battery is discharged, the less ampere-hours it will furnish, as indicated in the table below, which gives the output of a 320 ampere-hour battery when different currents are drawn from it until completely discharged.

Amperes	40	48	64	96	128
Hours	8	6	4	2	1
Amp-hrs.	320	288	256	192	128

How many ampere-hours were required to charge this battery if its ampere-hour efficiency was 90% at normal load (the normal load for all except vehicle batteries is taken as the current which can be supplied continuously for eight hours)? What was the ampere-hour efficiency at the two-hour discharge rate? At normal load the output = 320; input = output ÷ efficiency = 320/.90 = **356 ampere-hours.** At the two-hour rate the output = 192; 192/356 = 54%.

A cell charged at 60 amperes and 1.7 volts for 7 hours consumes a total of $1.7 \times 60 \times 7 = 714$ watt-hours; discharged in 5.5 hours at 60 amperes and 1.2 volts, its output is $1.2 \times 60 \times 5.5 = 396$ watt-hours. This gives a "watt-hour efficiency" of 396/714=56%. The figure is lower than the ampere-hour efficiency because of the difference in voltage on charge and discharge. The example illustrates how the internal resistance of an Edison cell cuts down its efficiency; a lead cell with a smaller resistance for the same capacity shows less difference between charging and discharging voltages and hence has a greater watt-hour efficiency, though practically the same ampere-hour efficiency as the Edison.

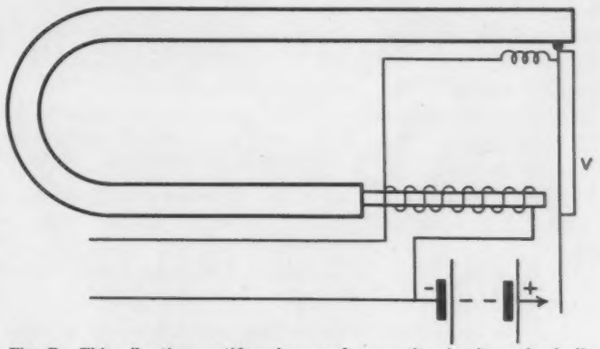


Fig. B.—This vibrating rectifier closes and opens the circuit mechanically, keeping step with the alternating voltage, so that current runs through the battery only in the proper direction for charging it.

Solutions for Previous Problems

218. Upper current = 2/8 = **.25 ampere.** Current in slide wire = **.1 ampere.** By the law of the bridge, since the upper left resistance is 3 times the upper right, a must equal 3 times b. Hence **a = ¾ of 24 = 18 in.; b = 6 in.**

219. Voltage generated = **1.03 volts.** Terminal voltage = .15 × 1.886 = **.28 volt.** Resistance in cell = (1.03 — .28) ÷ .15 = **5 ohms.**

220. Current = 42.8 ÷ (9.6 + 76) = **.5 ampere.** Terminal pressure = .5 × 9.6 = **4.8 volts.**

221. Each cell has a voltage drop of .3 × 1.9 = .57 volt, leaving its terminal voltage = .5 volt. Battery terminal voltage required = .3 × 60 = 18 volts. Then 18/.5 = **36 cells needed.**

222. 13/2 of 10 = **65 ohms** in soil cup.

Problems on Charging

223. If a "6-volt" lead battery is to be charged at the rate of 5 amperes, what resistance must be put in series with it on a 110 volt d.c. circuit? The cells have .01 ohm each and generate an average of 2.2 volts each.

224. What is the efficiency of this method of charging?

225. Find the voltage which must be applied to charge at a rate of 16 amperes a 60 cell battery if each cell has .0125 ohm and generates 2.1 volts.

226. Is the upper end of the horseshoe magnet of Fig. B a N or a S pole? Explain fully.

227. Find the weight of a pint of battery solution when a hydrometer reads 1.22. (A gallon of pure water weighs 8.355 lbs.).

228. Certain dry cells generate 1.5 volts each and have .12 ohm internal resistance each. If 18 of them are connected in series, what is the voltage and what is the resistance of the battery? What are these quantities if 3 of the cells are connected in series and 6 of these sets connected in parallel?

229. During the charging of a certain 100 cell battery the voltage applied averaged 225. A current of 25 amperes was used for 8 hours. On discharge the terminal voltage averaged 1.9 volts per cell, the current being 30 amperes for 6 hours. Find input, output, and watt-hour efficiency.

230. In a reverse current relay the shunt coil has 200 turns and a resistance of 350 ohms, while there are but 12 turns in the series coil. How many amperes flow, discharging the battery, to destroy the magnetism in the iron core if the voltage of the line falls to 105?

231. Find the volts used to charge a battery of 50 cells

at 40 amperes if each generates 1.46 volts and has .003 ohm internal resistance.

232. A vehicle battery was found to have an ampere-hour efficiency of 58% when discharged in 4 hours at 24 amperes. If discharged in 8 hours, what would be its efficiency, assuming its characteristics similar to those listed in the table above?

233. The battery of the above problem has an internal resistance of .0145 ohm per cell and generates 2.1 volts per cell. Find the voltage applied to it during charge, assuming the charging to take 8 hours. Find also the terminal voltage and watt output per cell during discharge at the 4-hour rate. Find the watt-hour efficiency under those circumstances.

234. A lead battery of 120 cells generates 2.1 volts per cell and has .008 ohm per cell. The charging generator has armature and brush resistance totaling .24 ohm and it is slowed down until it generates only 240 volts. Find amperes then flowing through the battery.

A University Course in Practical Cost Accounting

BY PAUL B. KELLY

(Do you know your Net Worth? How is it related to your Assets? In the following article, the sixth of the series, the author explains the fundamental equation which is the basis of the double-entry system of bookkeeping. These lessons are prepared by Mr. Paul B. Kelly, research accountant, under the direct supervision of H. R. Hatfield, Dean of the Faculties and Professor of Accounting at the University of California.—The Editor.)

LESSON V

DOUBLE-ENTRY THEORY: THE FUNDAMENTAL EQUATION OF ACCOUNTING

This course of lessons has consisted up to the present time of a detailed explanation of how the preliminary data with which the bookkeeper works is collected. At this point it is necessary to discontinue further description of practical routine and to devote some time to what is known as "double-entry theory." The reader will be struck by the fact that the next six lessons are theoretical rather than practical. It is true that these lessons are theoretical, but they are also intensely practical because they are so vitally connected with actual practice. An understanding of the few fundamental concepts upon which "double-entry" is based must be secured. "Double-entry" provides the means and method by which every-day transactions are analyzed. Without an understanding of this theory, the subsequent description of how the preliminary data is classified and condensed into the two monthly statements would be unintelligible to the contractor-dealer.

The next six lessons are a presentation of double-entry theory. They should be very carefully studied and thoroughly mastered. An understanding of the mechanics of bookkeeping is dependent upon the knowledge of this theory. The importance of these theoretical lessons can not be over emphasized. If they are understood the lessons which follow, dealing with the actual operation of the Standard Accounting System, will present no difficulties.

The Equation of Accounting

All double-entry bookkeeping is founded on what is known as the accounting equation. It may be best approached by means of a simple illustration.

Therefore, let us assume that you have $5000 which you borrowed from a relative for the purpose of starting business. The cash which you received you may spend as you please. Your only obligation is that you must according to your agreement repay the money at the end of five years. Your relative has no claim or control of this money. At the end of five years he may demand that you pay him $5000 in cash but in the meanwhile the money is yours and bears no direct connection to the debt incurred to obtain it.

Your financial position is accurately described by saying—

What you own, or Your property	is equal to	What you owe, or Your debt.

You could also state it—

The cash you own ($5000) = The debt you owe ($5000).

Notice that this equation consists of a statement that your assets are equal to your liabilities. If any change is made as the result of a business transaction, both sides of the equation are affected. If more money is borrowed or if part of the debt is paid, both sides of the equation are altered. One side of this equation must always continue to equal the other side. This equality must be maintained constantly. To keep this equation in equilibrium each business transaction must be recorded by means of two separate entries or by one "double-entry." This is the fundamental principle of double-entry account keeping. When its full significance is appreciated by you, you may consider yourself a pretty fair accountant.

Let us continue to be highly imaginative and assume that your uncle, who has just died, left you $5,000 in cash. You now become the owner of $10,000 cash. With the increase in the cash that you own, however, there has been no increase in your liabilities to offset it. The equation must now be materially changed and made to read:

Cash owned ($10,000) = Debt owed ($5,000) plus Net Worth ($5,000)

This equation may be expressed more concisely by saying:

Assets ($10,000) = Liabilities ($5,000) + Net Worth ($5,000)

Observe that the new item on the right side of the equation is called "Net Worth." It is given this name because it really represents the net amount that you are worth. The amount of your Net Worth is calculated in the following way:

From	What you own, or, your Assets
Subtract	What you owe, or, your Liabilities
The remainder is	Net Worth, or, your Proprietorship

In arithmetic you learned that to prove a subtraction you add the lower two terms; their sum should equal the first amount. That is what is always done in bookkeeping, for subtraction is a clumsy process. Instead of making our equation

Assets — Liabilities = Net Worth

we will always say,

Assets = Liabilities + Net Worth

Be sure that you understand this equation perfectly because it is the key to everything in double-entry accounting. You may understand it more readily by considering it in this form:

What you own (Cash $10,000)	Is represented by	What you owe, or, The claims of others ($5,000) and Your interest in the business, Or, your Net Worth ($5,000)

The equation in the original form was changed by a double entry into this later form in the following way:

Old Equation	Cash	5,000	= Liabilities	5,000		
Double Entry	Cash	5,000	Net Worth	5,000		
New Equation	Cash	10,000	= Liabilities	5,000	+ Net Worth	5,000

We will now suppose that you decide to buy an automobile for future business use. You purchase a Ford for $400. By making this purchase you changed the equation. This brings us to the essential nature of every business transaction. **Every business transaction is a transfer of money or of money's worth necessitating a giver and a receiver and an exchange of values.** You exchanged cash for an automobile; you now have an automobile but less cash. The left side of the equation has been increased and decreased by equal amounts. There has been no change in the right side of the equation for Liabilities and Net Worth have not been altered. You have merely changed the kind of assets that you own. So long as the total assets remain the same the equilibrium of the equation is not affected. A business transaction, such as this, which merely changes the type of asset, is recorded by an entry of **value received** and of **value paid out.** There is a plus (+) entry to one asset account and a minus (—) entry to another. The equation now reads:

Cash owned $9,600 plus Auto owned $ 400	=	Liabilities $5,000 plus Net Worth $5,000

Business transactions may be classified into two kinds—

1. Transactions that affect **both** sides of the equation and which are recorded by means of entries that **either increase, or, decrease both** sides of the equation **equally.**

2. Transactions which affect **one** side of the equation, **only,** and which are recorded by entries that **merely increase one asset and decrease another** by the **same amount.**

This is an important classification. **Memorize it.** Study the black type; it is very significant.

We will next suppose that you are led to believe that a Ford automobile would be inadequate for your contemplated business. You have, therefore, sold it and made a profit because of the increase in price. You give up the auto which cost you $400 and receive $450 cash. The net profit on the transaction is $50. The left side of the equation now amounts to $10,050, which is $50 more than the right side. Since our rule requires that the equation be kept in balance we must show the $50 profit on the right side also. The profit you made really constitutes an increase in your Net Worth. The equation is therefore changed to read:

Cash $10,050 = Liabilities $5,000
plus
Net Worth $5,050

We will next assume that you really begin business. You purchase the following for cash:

Auto	$1,000	Furniture & Off. Appliances	$ 500
Tools	500	Merchandise	3,000

You also buy an additional $2,000 worth of merchandise on thirty days' credit from the Pioneer States Electric Company.

Our original equation with the entries necessitated by these transactions would be:

Cash	+10,050	Liabilities	+ 5,000
Auto	+ 1,000	Net Worth	+ 5,050
Cash paid for auto	— 1,000		
Tools	+ 500		
Cash paid for tools	— 500		
Furniture and office appliances	+ 500		
Cash paid for F. & O. A.	— 500		
Merchandise (for cash)	+ 3,000		
Cash paid for merchandise	— 3,000		
Merchandise (for credit)	+ 2,000	Owed to P. S. E. Co	+ 2,000
Total	+17,050	Total	+12,050
Total	— 5,000	Total	— 000
Net	+12,050	Net	+12,050

Our equation has grown exceedingly in size. With many transactions it would become far too complex to be of any use. A number of steps in its simplification may be made. The first of these steps is to provide individual columns for the plus (+) and the minus (—) items on each side of the equation (p. 524). This device makes the separation of plus and minus items automatic. Each of these columns may be added separately. Note one important peculiarity of this arrangement. On the left side of the equation, the left column is + and the right is — ; on the right side of the equation the left column is — and the right column is +. We may state it another way:

Both inside columns are — and both outside columns are +. This arrangement is wholly artificial. It is always followed because of usage and accepted

Item	+	—
Cash	10,050	
Auto	1,000	
Cash		1,000
Tools	500	
Cash		500
F. & O. A.	500	
Cash		500
Merchandise	3,000	
Cash		3,000
Merchandise	2,000	
Total	17,050	5,000
Total —	5,000	
Net +	12,050	

=

Item	—	+
Liabilities		5,000
Net Worth		5,050
P. S. E. Co.		2,000
Total	000	12,050
Total —		000
Net +		12,050

practice. Get this point thoroughly in mind for it is an important one in bookkeeping technique.

The minus or negative columns are provided for convenience only. They might be dispensed with. In them are entered deductions from the positive amounts. The minus items are not real factors in the equation. They are subtracted from the plus or positive amounts as shown in the illustration. The balance on each side of the equation must always be a positive quantity. This is an invariable rule. Balances are never represented by minus amounts.

The minus columns although only a convenience are, however, very important. They are used universally. These four columns are the elementary tools of double-entry bookkeeping. You should understand their use thoroughly for every journal entry is made on this framework.

Fix this chart in your mind.

+ Left	— Right
Assets, or, what you own.	Reductions in the amount of Assets.

=

— Left	+ Right
Reductions in the amount of Liabilities and Net Worth.	Liabilities and Net Worth.

Our next step in simplification is to provide a device by which the plus and minus items for each kind of property owned and each kind of debt owed are automatically segregated. We need to know everything available concerning each kind of asset and liability. To provide this information readily we resort to the arrangement shown in the following table. Notice that each item such as Cash, Auto, and Merchandise is provided with two columns—one for + entries and one for — entries. A complete useful record can be more easily kept by this scheme.

side of the equation and compare them to the total of the net + balances on the other side of the equation. The two totals should of course agree.

This lesson should be carefully re-read. It is extremely important to master these first steps. You are advised to take a plain sheet of paper and to rule it similarly to the form shown below. Enter the + and — values of the following transactions, total each column, subtract the minus from the plus columns, and prove by totals as in the illustration just given. The total + amounts on each side should amount to $10,500.

If you do not secure this amount, do your work over until it is correct. Working this exercise immediately will fix the essentials of this lesson in your mind. You must apply this theory in order to learn it. When you find you are entering any transaction correctly you may consider yourself an accountant.

Begin with our original equation:

Cash 5,050 + Auto 1,000 + Tools 500 + Fur. & Off. Appl. 500 + Mdse 5,000 = Liabilities 7,000 + Net Worth 5,050.

Now enter the following transactions:

1. You sell mdse which cost you $2,000 for $3,000 cash.
2. You pay $1,000 of the debts you owe.
3. You lose a set of stocks and dies that cost you $50.
4. You sell mdse costing $600 for $800 cash.
5. You sell mdse costing $1,500 for $1,200 cash.

Transactions	Cash		Auto		Tools		Furniture and Office App.		Merchandise			Liabilities		Net Worth	
	+	—	+	—	+	—	+	—	+	—		—	+	—	+
Original Equation	10,050												5,000		5,050
Purchased Auto		1,000	1,000												
Purchased Tools		500			500										
Purchased Fur. and Off. App.		500					500								
Purchased Mdse. for Cash		3,000							3,000						
Purchased Mdse., 30 days' time									2,000				2,000		
Totals	10,050	5,000	1,000	000	500	000	500	000	5,000	000		000	7,000	000	5,050
—Amounts deducted	5,000		000		000		000		000				000		000
Net + amounts	5,050		1,000		500		500		5,000				7,000		5,050

Total of + Balances 12,050 = Total of + Balances 12,050.

In this record we have totaled each column. From the total of the plus column we have in each case subtracted the amount of its minus column. The result is the net + balance. Then to prove that the work is correct we add all the + balances on one

6. You purchase $2,000 worth of mdse paying $1,000 cash and agreeing to pay the remainder in 30 days.
7. You buy a set of stocks and dies for $75 cash.
8. You pay $2,000 of your liabilities.
9. You sell your auto which cost you $1,000 for $600 cash.
10. You immediately purchase another auto for $900 cash.

Business Activities in Western Market Centers

SAN FRANCISCO

Throughout the rural districts in central California there is apparent a decided feeling of optimism; there is an abundance of farm labor which has naturally resulted in improved efficiency and there is no apprehension of a water shortage during the present season, as there will not be a power shortage in the irrigated districts depending on electric pumping of water. Crop conditions are as a rule reported as "good." Although there remains a considerable portion of last year's crops yet to be disposed of, the acreage planted to this season's crops is practically the same as that of last year. Further cooperative agreements among the various growers will undoubtedly stabilize prices. In the Bay cities business conditions are not as good as they have been during the early spring. The strike in the printing and building trades has had a detrimental effect. Work on the several large buildings now under construction has been halted or slowed down considerably. The Builders' Exchange has issued a statement that seventy-five per cent of the men employed in the building trades are not at work on account of the action of the seventeen crafts involved in the wage controversy. While wholesale business is fair, retail buying has slackened off and collections are slow. Financial conditions are easier but merchants are conducting their business along conservative lines.

An event of importance to industry in this section is the bringing in of the first unit of the Caribou power plant of the Great Western Power Company, the first power being put on the line May 7. The power shortage of the past few years has had a detrimental effect upon industry and agriculture. This was partly due to a shortage of water and partly to a lack of sufficient water storage capacity at the power plants. With the further use of the large storage of Lake Almanor one factor effecting power shortage is definitely disposed of with this particular company, and, through interconnections, this will have a beneficial effect upon the whole Pacific Central district.

LOS ANGELES

New building continues to be the principal item of business progress in Southern California, with the permits for April breaking all previous records. During this month there were 2,904 permits totaling $7,250,000. Of these 1,150 were for new dwellings and 43 for flats, an element which indicates continued improvement in the housing situation. Bank clearings for the month were $342,000,000, as contrasted with $329,000,000 for the same month in 1920, indicating a gain in the face of a falling market. The credit situation continues satisfactory with the banks reporting plenty of funds available for legitimate purposes. Collections are fair to good. The investment market is firm, manufacturing concerns report increased production and retail trade is brisk. Unemployment, which has never been serious in this city, is lessening. The general situation may be considered very satisfactory. In the moving picture industry production remains on a curtailed basis and there is not the tendency to make expensive productions. Through the rural districts conditions are still somewhat unsettled because of uncertainty in the marketability of citrus fruits, particularly lemons. The successful shipment of fruit by all-water-route has had a stimulating effect.

SALT LAKE CITY

While there is not much change in general business conditions as a whole, it is felt that the bottom has been reached, and although the process will be slow, improvement is predicted from now on. The depressing effect of the shutdown in the copper mining industry will, of course, be felt in many lines of industrial activity until that situation is straightened out.

As a result of some increased activity in the building line, the local hardware trade reports general business improving. This is also true of the lumber trade. Prices of building material are lower, and indications are that many new homes will be erected this spring and summer.

In the electrical trade, retail dealers are continuing intensive advertising, and business is reported as fair, with improvement expected as building operations continue to increase. The demand for line material and electrical equipment is slight, of course, as compared with normal conditions.

Collections, in general, are slow.

In the agricultural sections conditions are rather unsettled, because the market for farm crops is uncertain. The sugar beet growers, however, have arrived at a definite contract schedule for beets, which assures the beet sugar farmer a good profit and a certain market.

The unemployment problem is rather serious, and county and municipal authorities are attempting to relieve this situation as much as possible by providing work on roads, public improvements, etc., as far as their financial resources will permit.

PORTLAND

Steady improvement in business conditions in Portland is indicated by the fact that bank clearings for the month of April showed a substantial increase over preceding months of the year, and the same was true of the volume of building permits. The bank clearings for April aggregated $139,327,047, which is more than $6,000,000 in excess of the clearings for March. Building permits for April were nearly half a million dollars in excess of permits for March. Residence building permits for the first four months of this year show an increase of nearly $400,000 over residence permits for the entire year 1920.

Retail business continues backward in spite of favorable weather conditions and some decrease in the number of unemployed. Orders received by jobbers are mostly to provide for current wants, and country buying is not expected to increase much until the next crops are harvested and sold.

Lumber production is about 33% below normal, with a gradual upward trend. It is not expected that there will be a general revival of the lumber business before July.

Grain and flour exported from Portland during April established a new record total of well over $4,500,000 in value. This figure is nearly $2,000,000 greater than the value of the wheat sent offshore in March and is well over the wheat export record of any month in the history of the port.

SEATTLE

Heralding the resumption of building operations on the scale which obtained prior to the war, announcements have been made in Seattle recently relating to the award of contracts for public, semi-public and business structures, totaling in excess of $4,000,000. The largest of these building projects calls for the erection of a high school in Seattle to cost complete $1,250,000, the structure to be known as the Roosevelt School. The general contract for the erection of this building is held by the Rounds-Clist Company, Walker Building, Seattle. Aside from this contract, the immediate construction of two large apartment structures, totaling a cost of $600,000, has been announced. Residence construction, which has kept up fairly well during the spring, is showing renewed activity.

There is a general feeling among retailers and merchants in Seattle that the buyers' strike, which has almost paralyzed business in the Northwest for the past few months, is lifting, and there is a disposition on the part of the public to buy somewhat more freely than for many months past. This condition can undoubtedly be attributed directly to an improvement in the employment situation, which has been bettered to considerable extent by the resumption of work in industrial plants, including lumber manufacturing establishments. Logging camps throughout this district are rapidly resuming operations, absorbing large numbers of unemployed men. Wages are uniformly lower in every line of industry.

With the gradual resumption of industrial activities, renewed building construction, the enormous amount of road and highway work being undertaken by cities, counties and state in Washington, there is a distinct feeling of optimism prevailing which has not before been expressed.

One Hundred Builders of the West

JOHN A. BRITTON

whose undisputed title of "Dean of the electrical industry" in the West makes him an outstanding figure among the one hundred builders of the West composing the distinguished group to whom this issue of Journal of Electricity and Western Industry is affectionately dedicated.

The experience and vision of such leaders in utility development as John A. Britton, Wigginton E. Creed, R. H. Ballard, A. G. Wishon, John B. Miller and Mortimer Fleishhacker, joined to that of leaders in Chambers of Commerce, in industry and in banking, will make the sessions of June 10, 1921, the most inspiring and powerful feature of the forthcoming convention of the Pacific Coast Division, National Electric Light Association.

ONCE upon a time there was a youth who was offered the position of collector with a small gas company, and on asking what the prospects were, was told that there were none in particular. Today he is not only nationally known as vice-president and general manager of one of the largest public utility concerns in the country, but is familiar throughout the West as "the Dean of the Electrical Industry."

The life of John A. Britton, typical leader in western utility development, strongly resembles the fabulous biographies utilized to illustrate certain works on success, the main difference being that this one happens to be strictly true. The hero of it was born in Roxbury, Mass., in 1855, but came, or rather was brought, to San Francisco thirteen years later, in the early days when the street railway service consisted of a single leisurely horse-car line.

His high school course was cut short by the necessity of earning a living, and he went to work temporarily in a grocery store where he arose at five in the morning and learned to sell everything from shoestrings to bacon. He asserts that at this time he was able to carry a 100-lb. sack of potatoes up a long flight of steps without stopping for breath. In the evenings he went to night school, and soon became an expert stenographer.

He left the grocery store for a clerical position with the San Francisco Musical Institute, and soon afterwards, in April, 1869, set his foot on the first rung of his chosen ladder by entering the office of Chas. A. Lowe, a San Francisco lawyer. It may be a surprise to some to learn that John A. Britton did not grow up dreaming of 220,000-volt transmission lines, and that the great ambition of his youth was to be a lawyer. Two accidents are mainly responsible for the fact that the electrical industry and not the legal profession boasts of him today. A southern gentleman who occupied a desk in the office of Curry and Evans, the second law firm with which John Britton worked, had taken a great fancy to the able young assistant, and trusted him with numerous details of his affairs. When this gentleman died, in December, 1873, John Britton was able to render considerable assistance in straightening up his affairs, and was asked by Joseph G. Eastland, the executor of the will, to continue the collection of rents from the properties as before.

Early the following year Mr. Eastland, then president of the Oakland Gas Company, offered him a position as collector, and as he was feeling the strain of office work, he decided to make the change for a year. He went to work for the munificent salary of $50 a month, out of which he spent $7.50 a month in commuting from San Francisco to Oakland. To save carfare between home and the ferry he hung on to express wagons, and secured free transportation in various other resourceful if irregular ways. He had to leave for work at about 5:30 in the morning, and often did not reach home until after 10 o'clock at night. His duties were as varied as his hours were long. He figured on the payroll as collector, but the accomplishments of a collector were expected to range, apparently, all the way from making out bills to firing boilers, using a pick and shovel, and repairing meters. This strenuous routine was somewhat alleviated by the fact that the superintendent's daughter, niece of Joseph G. Eastland, and the present Mrs. John A. Britton, used to drop in almost every day,— doubtless to see her father.

At the end of the appointed year Judge Evans sent for his former clerk to offer him a law position in the office of an attorney in San Francisco, whereupon he handed in his resignation to the gas company. Before he had even taken up his new duties, however, his prospective employer fell from his horse and was killed. John Britton promptly returned to the gas company and canceled his resignation. Thus a chance meeting threw him into the public utility game, and an accident prevented him from leaving it.

In the Oakland Gas Company both he and his salary progressed steadily, but without any dramatic leaps. From bookkeeper he became secretary of the company, partly in recognition of the improved accounting system which he introduced. In 1895 he became chief engineer, and in 1898 was elected president. One of the secrets of his popularity as an executive head was his policy of "the open door." He made a point of being accessible not only to visitors but to his staff, and no barricade of locked doors, "Private" signs, and impassable clerks cut him off from easy human intercourse with those who worked with him and for him. It is not surprising, therefore, that when the company sold out to the California Gas & Electric Corporation, John A. Britton occupied the new presidential chair. In 1905 the process was repeated when the smaller companies became subsidiaries of the Pacific Gas & Electric Company.

With the growth of this company, John A. Britton changed his title to that of vice-president and general manager, a position which kept him in closer personal touch with the everyday activities of the organization, and which he has held from 1908 until the present time.

His work as a public utility executive is too well known to call for comment. His contribution as a citizen is almost equally familiar to the thousands who know him as chairman of the San Francisco chapter of the American Red Cross, a Regent of the University of California, a Director of the Panama-Pacific International Exposition and as one of the most active promoters of San Francisco's musical enterprises and all that is best in her civic life. As a man he holds a unique place in the affections of his friends, acquaintances, and multitudinous admirers. His deep-rooted kindliness and tact, and his willingness to acknowledge the other man's rights have won him a wide personal regard seldom achieved in so busy a life, and his title "Dean of the Electrical Industry," accorded to him, both by those who know him and those who know of him, has always been a term not only of respect and admiration, but of genuine affection.

BENJAMIN IDE WHEELER, March 15, 1917. President Emeritus, University of California. Builder of Men and Character.

JOHN A. BRITTON, April 1, 1917. Vice-President and General Manager, Pacific Gas & Electric Company. Dean of the Electrical Industry—An Inspiration to Men.

RUSSELL H. BALLARD, April 15, 1917. Vice-President and General Manager, Southern California Edison Company. Helpful Intercompany Relations Throughout the Nation.

HARRIS J. RYAN, May 1, 1917. Professor Electrical Engineering, Stanford University. Important High Tension Transmission Research.

C. E. GRUNSKY, May 15, 1917. Consulting Civil Engineer. Leader of Thought in Commonwealth Discussion.

FRANK G. BAUM, June 1, 1917. Consulting Electrical Engineer, Pacific Gas & Electric Company. Engineering Advance in Hydroelectric Construction.

CHARLES C. MOORE, June 15, 1917. President, Charles C. Moore & Co. Vision Builder for Panama-Pacific International Exposition.

M. M. O'SHAUGHNESSY, July 1, 1917. Chief Engineer, City of San Francisco. Sound Judgment in Municipal Water Supply.

HERBERT HOOVER, July 15, 1917. Secretary of Commerce. Best Typifying the Engineer in Public Life.

E. C. JONES, August 15, 1917. Consulting Gas Engineer. Noted Inventor in Oil Gas Generation.

W. W. BRIGGS, September 1, 1917. Formerly General Agent, Great Western Power Company. Advancement in Electrical Retailing.

*JOHN M. ESHLEMAN, September 15, 1917. Former president, California Railroad Commission. Pioneer in Helpful Utility Regulation.

MAX THELEN, September 15, 1917. Former president, California Railroad Commission. War Activities of Utility Commissions.

JOHN D. GALLOWAY, October 1, 1917. Consulting Civil Engineer. Efficient Design of Irrigation Projects.

A. E. CHANDLER, October 15, 1917. Former president, California Water Commission. The Engineering Authority on Water Law.

JOSEPH N. LE CONTE, November 1, 1917. Professor of Engineering Mechanics, University of California. Wonderful Vision in Mathematical and Analytical Subjects.

SIMON BAMBERGER, November 15, 1917. Former Governor of the state of Utah. A Master Mind in Developing Intermountain Resources.

CHARLES W. BURKETT, December 1, 1917. Chief Engineer, Pacific Telephone & Telegraph Company. Effective Engineering Advance in Telephony in the West.

W. F. DURAND, December 15, 1917. Professor of Mechanical Engineering, Stanford University. An International Figure in Engineering Research During the War.

A. GRANT McGREGOR, January 1, 1918. Mechanical and Metallurgical Engineer. Design of Institutions for Reduction of Copper Ores.

JOHN MARTIN, January 15, 1918. Former president, California Gas & Electric Corp. Pioneer in Hydroelectric Developments.

JOHN D. RYAN, February 1, 1918. President, Montana Power Company. Whose Constructive Thought Made Railroad Electrification Possible.

EPES RANDOLPH, February 15, 1918. President, Southern Pacific Railroad Company of Mexico and Arizona. Who Saw the Great Possibilities of Railroad Service in the Southwest.

A. G. WISHON, March 1, 1918. Vice-president, San Joaquin Light & Power Corp. Who Developed the world's Greatest Electrical Pumping Area.

O. B. COLDWELL, March 15, 1918. Vice-President, Portland Railway Light & Power Co. Intercompany Helpfulness in the Northwest.

S. M. KENNEDY, April 1, 1918. Vice-President, Southern California Edison Company. Who by Precept and Example in Utility Operation is Winning the Public.

H. F. JACKSON, April 15, 1918. General Manager, Great Western Power Company. War Activities and Helpfulness of Utility Companies.

HENRY T. SCOTT, May 1, 1918. President, Pacific Telephone & Telegraph Company. Bringing Neighbors Nearer.

JOHN B. MILLER, May 15, 1918. President, Southern California Edison Company. Helpful Utility Service and Financing.

CHARLES MILLS GAYLEY, June 1, 1918. Head of the English Department, University of California. Increasing the Appreciation of Great Books.

ROBERT DOLLAR, June 15, 1918. President, Robert Dollar Co. Pan-Pacific Trade.

PAUL M. DOWNING, July 1, 1918. Vice-President, Pacific Gas & Electric Company. Who Has Attained High Standards in Hydroelectric Operation and Construction.

CHARLES M. SCHWAB, July 15, 1918. Former Director General, United States Emergency Fleet Corp. Promotion of Western Shipbuilding.

HENRY E. HUNTINGTON, August 1, 1918. President, Los Angeles Railway Corporation. Development of Rapid Transit Interurban Systems.

HERBERT A. BARRE, August 15, 1918. Executive Engineer, Southern California Edison Company. A Man of Vision in Design of High Voltage Long Distance Transmission.

J. H. ROSSETER, September 1, 1918. Vice-President and General Manager, Pacific Mail Steamship Company. Pacific Coast Shipping.

GUY W. TALBOT, September 15, 1918. President, Pacific Power and Light Company. Efficient Electrification of Northwestern Industries.

LUTHER BURBANK, October 1, 1918. Horticulturist. Constructive Horticultural Research.

EDWARD B. STRONG, October 15, 1918. Former Publisher, Journal of Electricity. Veteran Technical Publisher of the West.

GEORGE W. GOETHALS, November 1, 1918. Major-General, U. S. A. Builder of the Panama Canal.

A. C. BALCH, November 15, 1918. President, Midland Counties Public Service Company. Development of Natural Gas.

CHARLES K. FIELD, December 1, 1918. Editor, Sunset Magazine. Western Literary Advance.

D. C. JACKLING, December 15, 1918. Former President, Utah Power & Light Company. Mining Mountains of Copper.

JOHN H. LEWIS, January 1, 1919. Former State Engineer of Oregon. Unification of State Water Codes.

C. D. MARX, January 15, 1919. Professor of Civil Engineering, Stanford University. Constructive Ideals in Civil Engineering.

T. A. RICKARD, February 1, 1919. Editor, Mining and Scientific Press. Technical Journalism.

THOMAS A. EDISON, February 15, 1919. Inventor. Important Inventions in Electrical Application.

FREDERICK G. COTTRELL, March 1, 1919. Former Director, U. S. Bureau of Mines. Reclaiming of By-Products in Industry.

JULEAN ARNOLD, March 15, 1919. Commercial Attache to China. Improved Relations with the Far East.

FRANKLIN K. LANE, April 1, 1919. Former Secretary of the Interior. Conservation of Natural Resources.

H. M. BYLLESBY, April 15, 1919. President, H. M. Byllesby Co. Public Utility Executive Helpfulness.

W. W. CAMPBELL, May 1, 1919. Astronomer. Astronomical Research.

*HENRY MORSE STEPHENS, May 15, 1919. Late Professor of History, University of California. Noted Historian and Teacher.

DAVID C. HENNY, June 1, 1919. Consulting Hydraulic Engineer. Conservation of Water.

W. L. GOODWIN, June 15, 1919. Assistant to the President, Society for Electrical Development. Exponent of Cooperation.

STANLY A. EASTON, July 1, 1919. General Manager, Bunker Hill & Sullivan Mine. Electrification of the Mining Industry.

WYNN MEREDITH, July 15, 1919. Pacific Coast Representative, Sanderson & Porter. Sound Business in Engineering.

C. R. WEYMOUTH, August 1, 1919. Chief Engineer, Charles C. Moore & Co. Economies in Fuel Oil Practice.

CHARLES P. STEINMETZ, August 15, 1919. Erecting Engineer, General Electric Company. Scientific Electrical Research.

LEONARD F. FULLER, September 1, 1919. Board of Directors, Colin B. Kennedy Co. Advance in Radio Telegraphy.

JAMES H. McGRAW, September 15, 1919. President, McGraw-Hill Co. Helpful Ideals in Technical Publications.

JOHN B. FISKEN, October 1, 1919. Consulting Engineer, The Washington Water Power Company. Maintenance of the Professional Ideal of the Engineer.

A. W. LEONARD, October 15, 1919. President, Puget Sound Light & Power Company. Executive Management in Utility Control.

JOHN BARRETT, November 1, 1919. Director-General, Pan-American Union. Improved Relations with Pan-American Countries.

AURELIA H. REINHARDT, November 15, 1919. President, Mills College. Teacher of Ideals of Womanhood.

W. B. GREELEY, December 1, 1919. Chief Forester, United States Forest Service. Conservation of Timber Resources.

E. J. HALL, December 15, 1919. Vice-President, Hall Scott Motor Co. Development of Liberty Motor.

JOHN C. MERRIAM, January 1, 1920. Professor of Palaeontology, University of California. Advances in Palaeontological Research.

HENRY P. SUZZALLO, January 15, 1920. President, University of Washington. The University in Civic Life.

LEE H. NEWBERT, February 1, 1920. Manager, East Bay Division, Pacific Gas & Electric Company. Cooperation in the West.

W. D'A. RYAN, February 15, 1920. Illuminating Engineer, General Electric Company. Leader in Commercial Illumination.

GEORGE ELLERY HALE, March 1, 1920. Director, Mt. Wilson Solar Observatory. Research in Solar Astronomy.

S. L. SHUFFLETON, March 15, 1920. Pacific Coast Manager, Stone and Webster Co. Efficient Organization in Hydroelectric Construction.

REINIER BEEUWKES, April 1, 1920. Electrical Engineer, Chicago, Milwaukee & St. Paul Railroad. Transcontinental Railroad Electrification.

A. EMORY WISHON, April 15, 1920. General Manager, San Joaquin Light & Power Corp. The "Self-Interest Story."

DAVID P. BARROWS, May 1, 1920. President, University of California. Magnificent Ideals in University Service.

E. O. EDGERTON, May 15, 1920. Former President, California Railroad Commission. Helpful Ideals in Utility Regulation.

FRANKLIN T. GRIFFITH, June 1, 1920. President, Portland Railway Light & Power Company. Constructive Thought in National Water Power Development.

*BENJAMIN HOLT, June 15, 1920. Late President, Holt Manufacturing Co. Service to Western Agriculture.

G. E. QUINAN, July 1, 1920. Electrical Engineer, Puget Sound Light & Power Company. Safety Control in Transmission Line Construction.

J. D. ROSS, July 15, 1920. Superintendent of Lighting, City of Seattle. Municipal Distribution of Hydroelectric Energy.

J. B. SCHERER, August 1, 1920. President, California Institute of Technology. High Standards of Technical Education.

JOHN S. McGROARTY, August 15, 1920. Author and Playwright. Interpretation of the Spirit of the Spanish Pacific.

W. G. KERCKHOFF, September 1, 1920. President, San Joaquin Light & Power Corp. Development of Lumber and Power Industries in the Southwest.

FREDERICK LAIST, September 15, 1920. General Manager, Washoe Reduction Works, Anaconda Copper Mining Co. Research in Methods of Copper Production.

D. L. HUNTINGTON, October 1, 1920. President, The Washington Water Power Company. Efficient Public Utility Organization.

R. C. STARR, October 15, 1920. Construction Engineer. New Ideals in Hydroelectric Construction.

*RAPHAEL WEILL, November 1, 1920. Late Vice-President, The White House Co. Better Merchandising Methods.

ELWOOD MEAD, November 15, 1920. Professor, Rural Institutions, University of California. Development of Western Farm Lands and Institutions.

ROBERT M. KEENEY, December 1, 1920. Director, Department of Metallurgical Research, Colorado School of Mines. Research in Electro-Metallurgy.

ARTHUR P. DAVIS, December 15, 1920. President, American Institute of Civil Engineers. Reclamation of Arid Lands.

EDWARD L. BEACH, U. S. N., January 1, 1921. Commander, Mare Island Navy Yard. Efficiency in Western Naval Construction.

J. P. JOLLYMAN, January 15, 1921. Chief of the Division of Hydroelectric and Transmission Engineering, Pacific Gas & Electric Company. Technical Vision in 220-kv. Transmission.

*LESTER A. PELTON, February 1, 1920. Late President, Pelton Water Wheel Co. Inventor of Pelton Water Wheel.

HENRY R. HATFIELD, February 15, 1921. Dean of the Faculties, University of California. Better Accounting Methods.

EARL H. RICHARDSON, March 1, 1921. Manager, Ontario Works, Edison Electric Appliance Co. Inventor of the "Hotpoint" Iron.

F. W. BRADLEY, March 15, 1921. President, Bunker Hill & Sullivan Mining & Concentrating Co. Development of Mineral Resources.

PAUL SHOUP, April 1, 1921. Vice-President, Southern Pacific Company. Advances in Western Railroads.

STEPHEN I. MILLER, April 15, 1921. Manager, Northwest Electric Service League. Cooperation in the Northwest.

STEPHEN T. MATHER, May 1, 1921. Director, National Parks. Development of National Park Uses.

*Deceased.

PERSONALS

E. J. Condon, Jr., has recently been elected assistant general manager of the Intermountain Railway, Light & Power Company, and will have his offices in Colorado Springs, Colo. Mr. Condon will be the active executive in charge of the operation and management of the eight central station properties of the Intermountain company. He is also vice-president of the Condon Engineering Company of Chicago. During his past association with the operation of central stations, Mr. Condon has been able to effect remarkable economies in their operation. He is a graduate of Armour Institute, and later gained wide electrical experience during war service in France. He has been superintendent of construction for the Indiana Utilities Company, and manager of the Minnesota Electric Light & Power Company. He is an associate of the American Institute of Electrical Engineers and has served on the Indiana standardization committee.

Harley W. Brundige has been appointed president of the California State Railroad Commission.

Frank R. Lloyd has been appointed purchasing agent for the San Francisco and Oakland Terminal Railways.

W. H. Crawford and **W. M. Shepard,** of the Industrial section of the Northwestern Super-Power Survey, were in San Francisco recently in connection with the work of the survey.

George W. Edwards, president and general manager, Morganite Brush Company, of New York City, is on a business trip to Western cities, making a survey of Pacific Coast business conditions.

Janet Converse will establish a publicity bureau in San Francisco June first. Miss Converse has been with the California State Railroad Commission for nine years and in charge of the Los Angeles office for several years past.

George H. Middlemiss, formerly superintendent of distribution in the Sacramento division of the Pacific Gas & Electric Company, and at present superintendent of maintenance and repair of the Alabama Power Company, is visiting in California.

F. E. Newbery, president of the F. E. Newbery Company, with headquarters in Chicago, is a recent San Francisco and Los Angeles visitor, where he is inspecting the local contractor-dealer establishments known as the F. E. Newbery Electric Company, in these two cities of the West.

C. I. Rodes has been appointed chief hydraulic engineer for the California State Railroad Commission to succeed **Chester H. Loveland,** who resigned the first of May. Mr. Rodes has been with the commission for two and a half years, and in engineering work connected with the application and use of water since being graduated from the University of California in 1902.

James M. Barry, formerly engineer of distribution for Great Western Power Company, has been promoted from the position of manager of the Eastern division of the Alabama Power Company to assistant chief engineer of the company. Mr. Barry was connected with the Northwestern Power Company after his graduation from the University of California and later was chief of the department of electricity for the city of San Francisco.

W. M. McInnis, purchasing agent for the merchandising department of the Reno Power, Light and Water Company, **M. Cameron,** sales agent in this department, and **Oscar Clifford,** salesman, and secretary of the Reno Association of Electrical Contractors and Dealers, attended the General Electric Company's merchandising conference held in San Francisco during the last week of April.

T. Blundell Brown, of London, England, a director of the British Columbia Electric Railway Company since 1905, is on a visit to Vancouver and Victoria to inspect the company's properties. Mr. Brown represents 95 per cent of the shareholders in the company who reside in England, and is taking the opportunity of going into the company's railway franchises, which are now the subject of negotiations.

H. B. Hommon has been appointed head of the sanitation work of the United States National Parks and will have headquarters in San Francisco. Previous to taking up this work he was in the United States Public Health Service for several years. **C. G. Hyde,** professor of sanitary engineering at the University of California, has been named as consultant in connection with the sanitation work of the National Parks.

S. C. Haver, Jr., of the Membership Committee, Pacific Coast Division, N. E. L. A., is receiving the congratulations of the entire West over the splendid showing of the Southern California Edison Company in the recent drive for members. He reports 492 renewals, 637 new subscriptions, or a total of 1129 Class B members for the Southern California Edison Company. This is a larger membership by some 200 names than was enjoyed by the Southern California Edison Company during last year, when Mr. Ballard was president of the national association.

R. S. Daniels, electrical engineer, with the Washington Water Power Company for 15 years, has left for Berkeley, Cal., to take a position as assistant to the chief engineer of the California-Oregon Power Company of San Francisco. The company operates a number of plants in southern Oregon and northern California. Prior to his departure Mr. Daniels was tendered a dinner by the Spokane section of the American Institute of Electric Engineers, of which Mr. Daniels has been chairman during the last year.

Paul B. Kelly, well known to the readers of Journal of Electricity and Western Industry as the author of "A University Course in Practical Cost Accounting," has left for an extended trip through the Orient. Mr. Kelly was graduated from the University of California with the class of 1920, with the degree of Bachelor of Sciences from the College of Commerce. He specialized in accounting during his undergraduate course, and was awarded the Flood Fellowship to pursue research work. Mr. Kelly has supplemented his studies by practical work with several industrial concerns. Before the compilation of the present course, which is being given in conjunction with the Extension Division of the University of California, he installed this system under actual working conditions in an electrical contractor-dealer store. The results were very satisfactory. Mr. Kelly recently explained the practical application of this system before the State Contractor-Dealer convention at Stockton.

H. Stanley Benedict, recently appointed commissioner on the California State Railroad Commission, is probably best known throughout the state, and the country as a whole, as the author of the treatise entitled "California and the Oriental," which was published by the State Board of Control of which he was a member, in 1920, and which has since been in demand by students of the Oriental in the United States. Mr. Benedict was the author of the bill creating the California State Board of Control when a member of the state assembly in 1911; in 1919 he was appointed by Governor Stephens to the Board, a position he held until appointed to fill the vacancy created by the resignation of Frank R. Devlin from the Railroad Commission. Mr. Benedict is an attorney by profession and has been resident in Los Angeles for the past thirty-three years. In 1910 he was elected to the California state assembly, and re-elected in 1912; he served as state senator in 1915, resigning in 1916 to be elected to Congress for the unexpired term of Governor Stephens. Mr. Benedict's wide experience particularly fits him for the exacting position on the State Railroad Commission.

A. C. Nodine, advertising manager for the Electric Vacuum Cleaner Company, is in San Francisco on a business visit.

Elwood Mead, of the University of California, addressed the monthly meeting of the San Francisco Bar Association on the subject of "Rural Development in California."

Wigginton E. Creed, president, Pacific Gas & Electric Company, has returned from eastern cities after an absence of several weeks. He has met many men prominent in the electrical industry.

Ralph Bennett addressed a meeting of the Synchronous Club of Los Angeles on the city's terminal problem, and as this is of general interest Mr. Bennett's observations were highly interesting.

Prof. Harris J. Ryan, of Stanford University, presented a paper on "The Atmosphere in Relation to the Insulation of Extra High Voltage Transmission Lines," at the regular meeting of the Los Angeles Chapter of the A. I. E. E.

W. T. Neill, formerly with the Public Service Commission of Oregon, and recently with Henry L. Gray, consulting engineer of Seattle, is now rate engineer for the Pacific Power & Light Company and the Portland Gas & Coke Company.

W. M. White, chief hydraulic engineer of the Allis-Chalmers Company, was an interested visitor at the recent opening of the Caribou plant of the Great Western Power Company. Mr. White is spending several days on the Pacific Coast in connection with his business interests.

C. E. Groesbeck, vice-president of the Electric Bond & Share Company, of New York, is a Salt Lake City visitor. Mr. Groesbeck was formerly vice-president and general manager of the Utah Power & Light Company, one of the properties operated by the Electric Bond & Share Company.

E. E. Brazier, who has been in charge of the automobile accessories sales department of the Capital Electric Company, has been promoted to the position of general sales manager of that company. Mr. Brazier has had a wide experience in the sales branch of the electrical industry, and is well qualified to handle the duties of his new position.

J. H. Bloedel, president of the Bloedel-Donovan Lumber Company of Bellingham, and a director of the West Coast Lumbermen's Association, at the Ninth Annual Convention of the U. S. Chamber of Commerce, held in Atlantic City, N. J., was elected a director of the Chamber.

Farland B. Nye, formerly with the Spokane Central Heating Company of Spokane, has been transferred to Tacoma to take charge of the offices of the Consumers Central Heating Company. Mr. Nye for years was with the Spokane Central Heating Company, where he worked under Harry A. Flood, vice-president and general manager.

C. W. Koiner, who for thirteen years has been general manager and mechanical and electrical engineer of Pasadena's municipal light and power department, was appointed city manager of Pasadena on the second day of May. The new position will give him the administration of all municipal affairs other than the library and legal departments.

R. S. Holland, who was formerly in charge of the electrical sales department of the Capital Electric Company, has been promoted to the position of credit manager of that company, and will also act as secretary of the company. Mr. Holland has been with the company for more than twenty years, serving in the capacities of secretary and sales manager.

W. L. Goodwin, widely known throughout the West as assistant to the president of the Society for Electrical Development, Inc., with headquarters in New York City, now becomes active manager of the Society due to the withdrawal of G. B. Wakeman, who for some years past has headed the managerial side of the Society. All strength to your strong right arm, Bill.

James R. Cravath, well-known consulting illuminating engineer, has bought an interest in the Pioneer Electric Company of Richmond, Cal., in which Charles S. Renwick is also associated. It is believed that this new company undertaking electrical contracting and dealing in and about the San Francisco region will have its substantial part in putting over the idea electrical in home and industry.

Franklin T. Griffith, president, Portland Railway Light & Power Company, has passed through San Francisco on his way east to attend the National Electric Light Association's Convention at Chicago. Mr. Griffith, it will be recalled, is chairman of the National Water Power Committee of the N. E. L. A., which has done such splendid work during the past year in unlocking the nation's resources.

H. G. Steele, formerly vice-president and manager of the Pittsburgh Transformer Company, is now the president and treasurer of the U. S. Electrical Manufacturing Co. of Los Angeles. Mr. Steele was born in Harrisonburg, Va., in 1881, and attended the public schools in Pittsburgh, Pa. Immediately after graduation from school he became employed by the Pittsburgh Transformer Company at the time of its formation in 1899. Beginning with a capital of $10,000 and a total volume of business of $20,000, that company grew in 20 years' time until last year its business totaled over $2,000,000. Mr. Steele then sold his interests in this company and became associated with Mr. C. E. Johnson of the U. S. Electrical Manufacturing Company of Los Angeles, at which time the latter company was reorganized and Mr. Steele became its president and treasurer. This reorganization has been effected with a view toward a greatly increased activity in the business of the U. S. Electrical Manufacturing Company. During the war Mr. Steele served as chairman of the Transformer Committee of the War Industries Board, and is an associate member of the American Institute of Electrical Engineers.

HAPPENINGS IN INDUSTRY

ASSOCIATION OF ELECTRICAL CONTRACTORS AND DEALERS FORMED IN RENO

The electrical contractors and dealers of Reno, Nevada, has recently formed the first association of this kind in the state. Meetings are held every Monday night and considerable work is being done in the standardization of prices. Plans are being made for several interesting meetings when this work is completed.

Frank O. Broili of the Nevada Machine and Electric Company, and also engineer with the Nevada State Public Utility Commission, is president of this association, and Oscar C. Clifford, salesman in the merchandising department of the Reno Power, Light and Water Company, is secretary.

The association is composed of the following members: Martinez Electric Company, Nevada Machinery and Electric Company, W. C. Gill, Shearer Electric and Auto Supply Company, Pacific Motor Company, Reno Power, Light and Water Company.

EDISON CRESCENT BAY CLUB

The employes of the Redondo Steam Plant of the Southern California Edison Company have organized a most unique and helpful institution known as the Edison Crescent Bay Club No. 1.

Monday, May second, will long be remembered by the employes of Redondo district and doubtless by the officials who honored the club with their company on that night. Everything was a grand success, from the fish barbecue cooked up by Martin Siglie and his "dad," to the closing hymn by Uncle Ben and Walter Quilliam, with the assistance of all present.

Those down to share the festivities were: President John B. Miller and his secretary, Luther Lee; Vice-President and General Manager R. H. Ballard; Vice-Presidents S. M. Kennedy and A. N. Kemp; Secretary H. E. Morphy; Manager of Operations B. F. Pearson; Assistant Manager Fred Lewis; Superintendent Don D. Morgan; Electrical Engineer J. A. Lighthipe; Publicity Manager Hon. Chas. H. Pierson; District Agent of Pasadena A. B. Wolluper, and Mr. Robert Sibley, editor of Journal of Electricity and Western Industry, of San Francisco.

MEETING OF ADVISORY COMMITTEE, CALIFORNIA ELECTRICAL COOPERATIVE CAMPAIGN

Among the matters that were decided at the last regular meeting of the Advisory Committee it was unanimously decided, in order to provide greater flexibility and efficiency, that the Advisory Committee should be relieved of the many details incident to the carrying on of the Campaign business, and that this committee should serve strictly in an advisory capacity to decide at all times on the policy of the Campaign; and, because of their affiliations with the various branches of the industry, make a closer study of the more important industry activities which should properly become Campaign functions. With this in view, it was decided to add an additional manufacturers' representative to the Advisory Committee, and a meeting is being called by the manufacturers' representatives to appoint their new member to the committee. The new arrangement will not necessitate the regular monthly meetings that were held in the past, and under the present plans, the Advisory Committee will meet every two months.

Robert L. Eltringham, formerly executive secretary, has been named manager of the California Electrical Cooperative Campaign and was given full charge of carrying on the work of the Campaign.

UTAH GOVERNOR APPOINTS WATER STORAGE COMMISSION

In compliance with the law enacted by the Fourteenth Legislature, providing for a State Water Storage Commission, Governor Charles R. Mabey has appointed the following as members of the commission: W. R. Wallace, E. M. Ashton, R. R. Lyman, W. L. Hansen, W. W. Armstrong, all of Salt Lake county; J. R. Murdock of Wasatch county; W. V. Creer of Utah county; A. F. Doremus of Tooele county, and Sam G. Dye of Weber county. The state engineer is ex-officio a member of the association.

The law creating the commission provides that the body shall conduct investigations relative to water supply for irrigation purposes, and that any county, city or other agency may co-operate with the commission in obtaining data on water supply in that county or city, and that they may contribute to the cost of the work.

Full and proper development and utilization of the state's water supply is the object of the creation of the commission, and it will take over, to a certain extent, the work done during the last two years by the Utah Water Storage Association.

An appropriation of $2500 was made by the legislature for the purpose of conducting investigations in relation to water supply. None of the appropriation is to be used in salaries, the members of the commission serving without pay.

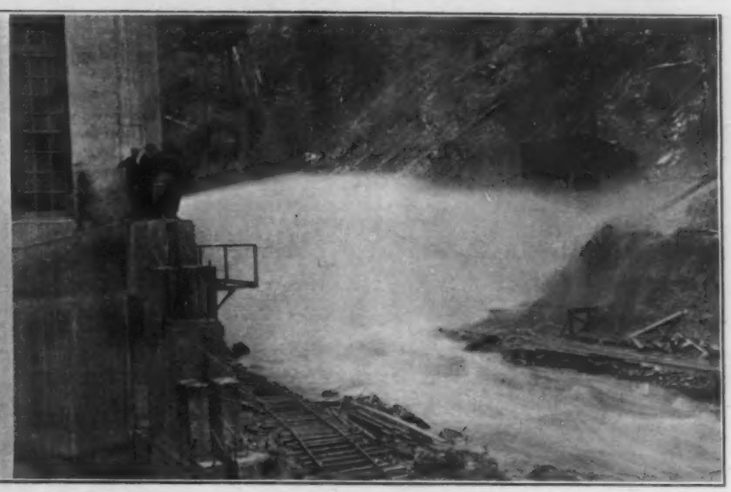
PORTLAND STARTS ADVERTISING 1925 WORLD'S FAIR

Portland, Ore., will have a World's Fair in 1925. Preliminary arrangements have been made, committees appointed and the financing of the undertaking assured. The accompanying cut was made from a three-color "sticker" which will be used to obtain publicity; that it illustrates a power house generating hydroelectric energy indicates that Portland is fully alive to the most important vitalizing factor in the development of the West. By emphasizing the part that electricity is playing in industrial development, the World's Fair at Portland will obtain the whole-hearted backing of the electrical interests throughout the West.

ROCKY MOUNTAIN ELECTRICAL COOPERATIVE LEAGUE AND DESERET NEWS TO CONDUCT ELECTRICAL COOKING SCHOOL

The Deseret News of Salt Lake City and the Rocky Mountain Electrical Cooperative League have instituted an annual electrical cooking school which will be held in the auditorium, Salt Lake City, the week of June 13-18, 1921. The feature of the cooking school will be the use of electric ranges for demonstration, under the direction of an expert in electric range cooking. Demonstrations will be made daily illustrating the simplest, easiest and most inexpensive way to prepare edibles. On Saturday there will be a competition for prizes. The electrical cooking school idea has the support of the electrical contractors and dealers individually and through the league, and of the power companies, and should prove successful in demonstrating the advantages of electricity in the household.

Miss Eleanor Fleishhacker starts Caribou plant

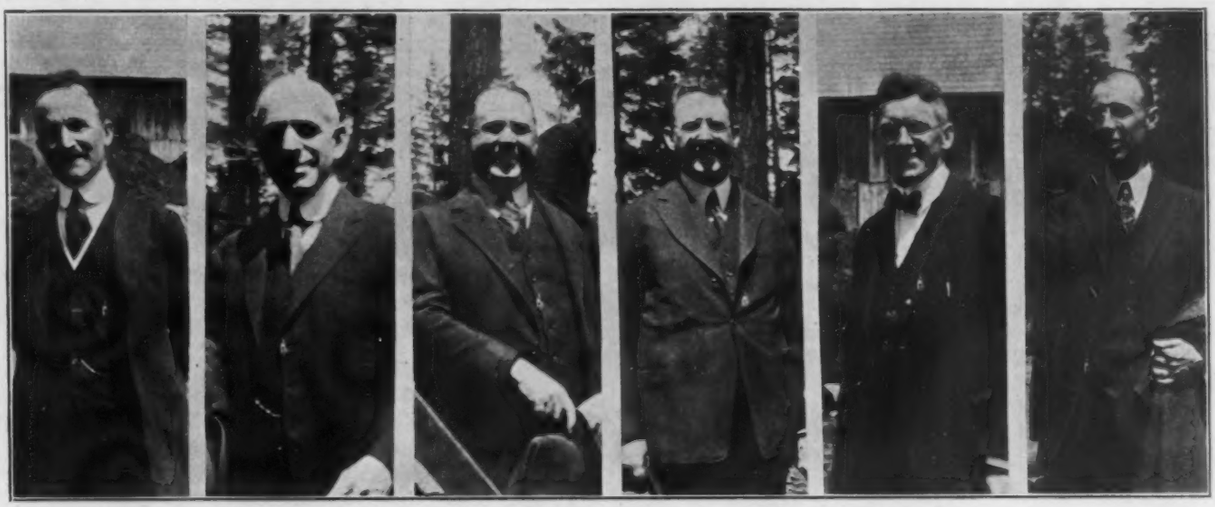


First water through generator at the Caribou plant, before lowering the nozzles.

THE PUTTING IN OF THE CARIBOU PLANT OF THE GREAT WESTERN POWER COMPANY

Long will be remembered the simple yet effective ceremony on Saturday, May 6, 1921, when the Caribou plant of the Great Western Power Company was officially put into service. With fitting words, Guy C. Earl, vice-president of the Great Western Power Company, told of the wonders of the modern harnessing of water power wherein the terrifying thunderbolts of Jove are put to the uses of man. Miss Eleanor Fleishhacker then in clear, distinct and impressive words said, "I christen thee Caribou Plant," and upon pressing the throttle the great power plant was set in motion, establishing a new world's record in high tension transmission of electricity and engineering construction. Mortimer Fleishhacker, president of the Great Western Power Company, then spoke of the difficulties involved in the modern financing of hydroelectric securities and outlined the wonderful possibilities for development on the Feather River. A thoroughly representative group of bankers, industrial, railroad and power company officials, editors and other prominent men of California and the West were invited by the company to witness the ceremony and go over the great work now under way on Feather River. The following were those in attendance:

Mortimer Fleishhacker, president, Great Western Power Company of California, San Francisco, Cal.
Mrs. Mortimer Fleishhacker
Miss Eleanor Fleishhacker
Mortimer Fleishhacker, Jr.
Herbert Fleishhacker, Jr.
Guy C. Earl, vice-president and general counsel, Great Western Power Company of California, San Francisco, Cal.
Mrs. Alice Wilder
H. F. Jackson, general manager, Great Western Power Company of California, San Francisco, Cal.
B. E. Alanson, 251 Montgomery Street, San Francisco, Cal.
W. A. Alberger, vice-president and general manager, San Francisco-Oakland Terminal Rys., 22nd and Grove Streets, Oakland, Cal.
Alden Anderson, president, Capitol National Bank, Sacramento, Cal.
W. G. Barnwell, 605 Market Street, San Francisco, Cal.
James B. Black, general sales manager, Great Western Power Company of California, San Francisco, Cal.
George W. Bernhard, district manager, Great Western Power Company of California, Napa, Cal.
A. H. Breed, Oakland Bank of Savings Building, Oakland, Cal.
John A. Britton, vice-president and general manager, Pacific Gas & Electric Company, 445 Sutter Street, San Francisco, Cal.
H. G. Butler, Power Administrator, Railroad Commission of California, Flood Building, San Francisco, Cal.
R. D. Brigham, vice-president, Anglo California Trust Company, San Francisco, Cal.
J. F. Carlston, president, Central National Bank, Oakland, Cal.
Dudley Cates, Marsh-McLellan Company, Insurance Exchange Building, San Francisco, Cal.



That electric power may be ready to serve the needs of a rapidly developing section of the West, these men have devoted themselves to the bringing in of the Caribou Plant of the Great Western Power Company. Reading from left to right they are:

J. M. Howells, consulting engineer, Great Western Power Co., whose vision conceived the Feather River hydroelectric development; **Mortimer Fleishhacker,** president of the Great Western Power Co., who appreciated the commercial possibilities and financed the development; **H. F. Jackson,** general manager of the Great Western Power Co., who heads the organization responsible for the operation of the Caribou plant; **W. M. White,** chief hydraulic engineer, Allis-Chalmers Co., designer of the hydraulic equipment for the Caribou plant; **J. H. Anderton,** electrical engineer, Stone & Webster Co., in charge of installation of electrical equipment under S. L. Shuffleton; **J. A. Koontz,** electrical engineer, Great Western Power Co., designer of the record-breaking 165,000-volt transmission line which brings the power to the bay cities.

L. R. Coffin, Stone and Webster Engineering Corp., San Francisco, Cal.
John J. Daly, assistant city attorney, City Hall, San Francisco, Cal.
B. H. Dibblee, E. H. Rollin and Son, 300 Montgomery Street, San Francisco, Cal.
Harry Donoho, San Francisco Chronicle, San Francisco, Cal.
E. O. Edgerton, 707 Alaska Commercial Building, San Francisco, Cal.
Albert L. Ehrman, 228 Montgomery Street, San Francisco, Cal.
W. G. B. Euler, superintendent of operation, Great Western Power Company of California, San Francisco, Cal.
J. H. C. Gainforth, Pacific Coast financial correspondent, Philadelphia Ledger, San Francisco, Cal.
John H. Gerrie, financial editor, San Francisco Bulletin, San Francisco, Cal.
Will Gerstle, Northern Commercial Company, Alaska Commercial Building, San Francisco, Cal.
Leon E. Gray, assistant city attorney, Oakland City Hall, Oakland, Cal.
Chaffee E. Hall, Great Western Power Company of California, San Francisco, Cal.
P. W. Ham, chief engineer, Great Western Power Company of California, San Francisco, Cal.
L. M. Hardie, district manager, Great Western Power Company of California, San Francisco, Cal.
J. M. Howells, consulting engineer, Great Western Power Company of California, San Francisco, Cal.
Carl E. Heise, district manager, Westinghouse Electric & Manufacturing Company, San Francisco, Cal.
W. H. Hannam, Western Sugar Refinery, No. 2 Pine Street, San Francisco, Cal.
C. A. Horne, 413 First National Bank Building, San Francisco, Cal.
W. D. Hines, city editor, Examiner, San Francisco, Cal.
L. C. Hutt, Pathe News, 985 Market Street, San Francisco, Cal.
James Irvine, Crocker Building, San Francisco, Cal.
Samuel H. Kahn, vice-president and general manager, Western States Gas & Electric Company, Stockton, Cal.
E. J. Kendall, claims agent, Great Western Power Company of California, San Francisco, Cal.
C. L. Killam, district manager, Great Western Power Company of California, Rio Vista, Cal.
John A. Koontz, electrical engineer, Great Western Power Company of California, San Francisco, Cal.
M. D. Lack, secretary, State Board of Equalization, Sacramento, Cal.
E. W. Lindquist, district manager, Allis-Chalmers Company, 745 Rialto Building, San Francisco, Cal.
Hon. Irving Martin, Commissioner, Railroad Commission of California, Flood Building, San Francisco, Cal.
E. H. Martin, International News Service, Sharon Building, San Francisco, Cal.
John D. McKee, vice-president and treasurer, California Oregon Power Company, 507 Montgomery Street, San Francisco, Cal.
Hon. John Mitchell, State Board of Equalization, Sacramento, Cal.
Clifton H. Miller, 905 American National Bank Building, San Francisco.
F. W. McKechnie, managing editor, Daily News, San Francisco, Cal.
Emery Oliver, Natomas Company of California, Sacramento, Cal.
George W. Peltier, vice-president, The California National Bank of Sacramento, Sacramento, Cal.
L. A. Reynolds, assistant treasurer, Great Western Power Company of California, San Francisco, Cal.
Richard Sachse, chief engineer, Railroad Commission of California, Flood Building, San Francisco, Cal.
Robert Sibley, president, McGraw-Hill Company of California, Rialto Building, San Francisco, Cal.
James Schwabacher, Schwabacher Company, 665 Market Street, San Francisco, Cal.
G. B. Sanford, district manager, Great Western Power Company of California, Sacramento, Cal.
H. M. Simons, Anglo California Trust Company, San Francisco, Cal.
F. W. Smith, purchasing agent, Great Western Power Company of California, San Francisco, Cal.
Mason D. Starring, president, California Railway and Power Company, Merchants National Bank Building, San Francisco, Cal.
W. H. Spaulding, Great Western Power Company of California, San Francisco, Cal.
T. J. Tehaney, San Francisco Call, San Francisco, Cal.
T. C. Tilden, Anglo California Trust Company, San Francisco, Cal.
Rudolph W. Van Norden, Oakland Enquirer, Mills Building, San Francisco, Cal.
William Von Phul, president and general manager, Market Street Railway Company, 58 Sutter Street, San Francisco, Cal.
A. G. Wishon, vice-president and managing director, San Joaquin Light & Power Corp., Fresno, Cal.
F. H. Woodward, district manager, Great Western Power Company of California, Oakland, Cal.
W. M. White, chief hydraulic engineer, Allis-Chalmers Company, Milwaukee, Wis.

LOS ANGELES MAY VOTE $25,000,000 FOR COLORADO RIVER PROJECT

The special bond committee of the Los Angeles city council has recommended that a special election be held next fall at which time there may be submitted to the voters a bond issue providing $3,000,000 for extending and enlarging the water system, and $25,000,000 for developing of hydro-electric power in conjunction with other interests at the Boulder canyon site on the Colorado river.

As a result of the United States Reclamation Service investigations last fall, it is stated that bedrock has been found at a depth of less than 140 feet in the center of the channel, and that it is practicable to construct a dam at this point that will store 25,000,000 acre-feet. Power development at this site, according to A. P. Davis, director of the Reclamation Service, could be used (1) to pump water for irrigation on the area above gravity flow lines, (2) for municipal purposes in the cities and towns served by the project, and (3) for the use of other municipalities and for sale to private enterprises. City officials of Los Angeles have assured the Reclamation Service that the city would doubtless bond itself to aid in a major power development on the Colorado river.

POWER HOUSE TO BE CONSTRUCTED NEAR RENO

The Nevada Valleys Power Company is planning to erect, within the coming year, a 3500-hp. plant on the Truckee river, fifteen miles east of Reno. The plant will be known as the Ditho power house. Power will be used to supply the cities of Lovelock and Rochester as well as the Packard and Tungsten mines, located in the east central part of Nevada. Power for the operation of underground cars and mine machinery is greatly needed in these mining districts so that the completion of the plant will be welcomed. Power will also be distributed to the surrounding farm lands. Thirty-five miles of transmission line will be constructed to connect the Ditho power house with the line already built in connection with the power house at Lahonton Dam.

REHEARING ON COLUMBIA BASIN RATE DENIED

Petitions for a rehearing of the Columbia Basin rate case by Puget Sound and Astoria interests have been denied by the Interstate Commerce Commission, thus maintaining for Portland a differential of 10% over Puget Sound points and Astoria on rail shipments from the Inland Empire, granted by the Interstate Commerce Commission in January. The petitions were denied on the ground that no new evidence had been introduced. About 4500 square miles of rich territory is thus brought into the exclusive Portland rate district. This territory produces about 15,000,000 bushels of wheat, as well as considerable quantities of barley and oats, livestock, fruit and a good general trade.

UTAH PUBLIC UTILITIES COMMISSION PETITIONED FOR MODIFICATION OF POWER RATES

After discussing the matter for several days, the committee representing irrigation projects and users of irrigation power in Utah have decided to present to the Public Utilities Commission of Utah a petition for modification of power rates recently put into effect as a result of the commission's decision in case No. 248, granting certain increases to the Utah Power & Light Company. The new rates became effective March 25, 1921.

The petition will set forth that modification of these rates is necessary on account of generally poor conditions now facing the agriculturists throughout the state.

The petition will also seek to have abrogated a clause in the contracts which requires that users of power for irrigation pumping must deposit in advance 50 per cent of the seasonal minimum guaranty under the contract.

SOUTHERN CALIFORNIA POWER COMPANY INCREASES MEMBERSHIP IN N. E. L. A.

As the result of the recent campaign for new members and renewal of membership in the Pacific Coast Division of the N. E. L. A., the Southern California Edison Company reports 492 renewals, 637 new subscriptions, a total of 1129 Class B members for the company. This is an increase of over two hundred members for the past year, and is an indication of the active support this company is giving to the important work.

UTAH SUPREME COURT DENIES REHEARING IN SPECIAL CONTRACT CASE

The supreme court of Utah has denied the application of the Utah Copper Company and seventeen other large users of electric power, for a rehearing in connection with its decision on February 25th sustaining the Public Utilities Commission of Utah in the special contract case, whereby all existing special power contracts of the Utah Power & Light Company customers in Utah were declared discriminatory and ordered placed on standard schedules. The case was appealed to the supreme court by the consumers on the ground that the Commission had no authority to change any of the terms of the contracts because they were entered into prior to the creation of the Commission.

In denying the rehearing the court made it plain that it was not deciding as to the fairness of the rates, but as to the right of the Commission to change the terms of existing contracts. The decision reads in part as follows:

"The only question presented by counsel which requires consideration on this application is whether, as counsel suggests, this court has, in its decision, approved the order of the Public Utilities Commission in which it required the Utah Copper Company and some of the other plaintiffs to pay the temporary rates fixed by the Commission, which rates were in excess of the contract rates existing between the defendant Utah Power & Light Company and the several plaintiffs referred to. That question was not, nor was it intended to be, decided in any of those cases. As we viewed the matter, and as we now view it, that question was not involved in the proceedings, and hence was not decided. The question of whether the rates fixed by the Commission, and which it ordered the plaintiffs aforesaid to pay, were just and reasonable, or whether they apply to any one or more, or all, of the plaintiffs, or whether, under the circumstances, the Commission had the power to make and enforce them, was not considered and not decided."

The denial of the rehearing leaves the way open for appeal to the United States Supreme Court.

POSSIBILITIES IN STEEL INDUSTRY IN UTAH OUTLINED TO UTAH SOCIETY OF ENGINEERS

At the monthly meeting of the Utah Society of Engineers, held on April 20th, Morris Rosenblatt, general manager of the Utah Steel Corporation's plant at Midvale, Utah, predicted that Utah would ultimately become a steel manufacturing center equal in importance to some of the largest in the country. He said that geologists and metallurgists were conducting investigations of iron ore deposits in southern Utah, under the direction of the corporation, and that initial reports were of a nature to lend the greatest encouragement to further exploitation.

Mr. Rosenblatt called attention to the advantages of short hauls and lower freight rates, in case the iron deposits of Iron and Carbon counties prove to be of sufficient extent and of the required quality. This situation would be an important factor which would redound to the benefit of steel manufacture in Utah, he said.

Mr. Rosenblatt said that the Utah Steel Corporation is now producing 200 tons a day of finished product, and that it is making preparations for an immediately larger production, which will include steel rails of the lighter weights. Until the present time the corporation has been engaged in the manufacture of standard steel bars and rods. For the disposal of these products the company has an extensive field, which includes not only the Western states, but Japan, China and other foreign countries, which since the company began operations have been constant customers.

Initial steel production of the company began in 1917, though prior to that time much wrought iron had been produced. In the year mentioned, an open-hearth steel furnace was placed in operation, and since that time has continued steadily, scrap material collected throughout the intermountain region being utilized.

Crude oil as a fuel has been introduced of late instead of coal, the speaker said, and the results are so eminently satisfactory that the company is fervently wishing for the success of Utah oil prospecting, as a native oil source. Another difficulty which for a time confronted the company was that of obtaining desirable coke. This has been overcome by mixing the highly volatile coal of Utah with a coal of low volatile properties, the result of which has been a metallurgical coke of the required quality.

The corporation, Mr. Rosenblatt said, at present employs from 350 to 450 men. In 1920 the payroll amounted to $750,000, and in the same year the company produced steel to the value of $3,000,000. It is anticipated that the output this year will be more valuable, because of the plan to manufacture steel rails, pig iron, steel pigs and sheet iron in addition to steel bars and rods.

In conjunction with the address of Mr. Rosenblatt, three reels of moving pictures, showing details of the iron industry, were exhibited.

A large number of members of the society from many parts of the state were present, and before the meeting closed tentative arrangements were made for the members, and other engineers of the state, to visit the Midvale steel plant within the next few weeks, where they will study the process of steel-making.

NORTHWESTERN ELECTRIC CO. GETS INCREASE IN STEAM HEATING RATES

An increase of from 30 to 35 per cent in the steam heating rates of the Northwestern Electric Company for service in the city of Portland is made in an order of the Public Service Commission issued recently, following hearing and investigation on the company's application. The Commission found that the rates charged in Portland were lower than charged in any other city in the Pacific mountain territory.

WASHINGTON COMPANY'S APPLICATION FOR INCREASED STREET CAR FARES CONTESTED

The sessions of the Washington State Public Service Commission at Spokane to hear the application of the Washington Water Power and Traction Company for permission to increase street car fares, brought forth vigorous protests. Mayor Fleming stated that he would vote to release jitneys if the increase of fares to 8 cents was granted, and the attorney for the power company requested permission to amend the application for increase and ask for a 10-cent car fare in the event the city released jitneys. The city revived its suggestion for a merger of the two street railway systems as the only solution to the fare problem.

UTAH POWER & LIGHT COMPANY SEEKS INCREASE IN STEAM SERVICE RATES

The Utah Power & Light Company has applied to the Public Utilities Commission of Utah for permission to increase its rates for steam service which it now furnishes to twenty-eight buildings and to three groups of stores, the latter owned by the Newhouse Realty Company.

It is declared that the steam heating business of the company has never yielded its cost of operation, to say nothing of depreciation and a fair return upon the investment in steam plant; nor has the power company, according to the petition, received from any other source any compensation for the deficit in earnings realized from the plant.

The petition also declares that were the plant turned back to the consumers to operate they would be confronted with an increase of substantially 100 per cent in the cost of coal alone, which constitutes a large part of the operating expense.

The power company, in its petition, also declares that the carrying out of the plans which it has under way for the reconstruction and enlargement of certain of its plans to extend its service, will depend entirely upon the rates available for its steam-heating service, and the sufficiency of its revenue from such service to meet all changes on its capacity therefor.

A hearing was held on April 18th, and the commission now has the matter under advisement.

UNDERMINING PUBLIC UTILITY SECURITIES

Letter to the Editor

I enclose herewith a copy of a letter written to one of our clients, to whom we had submitted a list of California electric securities.

I do not know of anything more destructive than a campaign of this kind, based on misinformation and half-truths. If you have any way of bringing pressure on these people through your national organization, I am confident that every power company, every bank, every business man and every investment dealer in California will be very grateful, if you will use your influence to prevent a repetition of this destructive attack.

Very truly yours,

DAVID T. BABCOCK,

Los Angeles Mgr., Blyth, Witter & Co.

April 12, 1921.

(Following is the letter referred to by Mr. Babcock.)

Dear Mr. ———— :

I certainly appreciate your advising me that you have the sum of $12,000 to invest now, Mr. ————, and I will say to you in all frankness that I do not consider the list of securities you gave me as absolutely safe. They do not compare in any way,—soundness or stability—with the bonds of our offering.

To begin with, Mr. ————, there are half a billion dollars' worth of public utilities in default right now. Years ago, before the days of franchise restrictions, federal, state, and municipal regulations, bonds of this character found ready market, at from 4¾% to 5%, but today the situation is different, because of the increased cost of operation, muckraking of politicians, who, in many cases, have restrained commissions in control of public utilities from permitting an increase of revenue. Earnings have dwindled—in some cases being entirely wiped out—and, as a class, this type of security has fallen in the estimation of conservative investors.

While it is a very easy matter for public utilities to pay their interest, consider the losses investors are obliged to take in marketing utility bonds that they bought a few years ago. As an example of this, ———— ———— was originally put on the market at 96, and is now selling at 88. When an investor, especially of the business man type, takes even a paper loss, he becomes more cautious. He sees that the assets of public utilities are NOT liquid; he sees that in the event of a collapse, the loss would be enormous, because the salvage from a great part of the property would be comparatively nil.

At the present time, due to the scarcity of capital, borrowers must go to the extreme to secure accommodations from bankers and underwriting houses. A corporation, knowing that its bonds of themselves are not attractive, and consequently not in demand, must make concessions to win the favor of the public. Either additional security must be given, or an increased yield, for the banker demands for his clients additional interest for every sacrifice in safety and desirability. In the case of public utilities, since they cannot offer greater security and greater earnings, they must pay tremendously increased interest rates in order to stimulate public demand, which, without such stimulation, is virtually dormant.

It is a comparatively easy matter for us, Mr. ————, to sell bonds of our offering to investors who, in the past, have preferred public utilities, because investors today do not want to jeopardize $1,000 for an additional gain of $5.00 or $10.00 per year, and I know that you would be far happier and enjoy greater peace of mind with your funds invested in bonds of our offering, which have stood the test of every changing condition for more than 39 years without loss to any investor.

Do not depend upon ANTICIPATED earnings for the payment of your interest and principal; do not buy securities which are subject to depreciation because their success is dependent upon manipulation, legislation, the whims of men or changing conditions. The utilities you mentioned in your list are pyramiding their indebtedness almost every year. The more they borrow the lower their bonds go, because it weakens their financial position. Our bonds are SAFE bonds—they have proven their value—no one can question their safety.

Now, I will leave it to your good judgment to make the most judicious selection of securities for the money you now have available.

If there are any further points you wish to take up with me, why not call me on the 'phone—Broadway 000—just tell the operator to reverse charges. In our business we are also conscientious to protect the interests of our clients and those we would like to add to our list of customers, and serve them in any way possible. A reply from you by 'phone or mail, would be appreciated.

Trade Notes

Lakewood Engineering Company Appoints Pacific Coast Representative —

M. B. Rider has been appointed Pacific Coast representative for the Lakewood Engineering Company of Cleveland, Ohio, with offices in the Rialto Building, San Francisco.

Western Machine Company Appoints San Francisco Branch Manager —

C. Remschel, sales manager, Southern Sierras Power Company during the past nine years, has become branch manager of the Western Machinery Company, manufacturers of gas and Diesel engines, at San Francisco. The fact of Mr. Remschel's departure from Riverside was made the occasion of the presentation of a handsome watch from his associates, as a token of affection and regard. Mr. Remschel was a pioneer in the electrical development of the West, having been associated with the Edison Light & Power Company and the San Francisco Gas & Electric Company. Later he was with the Westinghouse Electric & Manufacturing Company at San Francisco and the Allis-Chalmers Company at Seattle.

Surf Manufacturing Company Moves to Evansville, Ind.—

The Surf Manufacturing Company, manufacturers of the Surf electric clothes washers, has been taken over by the Sunbeam Domestic Appliance Company of Evansville, Ind., and will move into the new daylight factory of the latter company this month. The name "Surf" will be retained for the product. The new factory provides more favorable manufacturing conditions and additional capital has been provided.

Seattle Has New Electrical Dealer Store —

The City Electric & Fixture Company, G. C. Burke, manager, a reorganization of the Burke Electric Company, recently opened an electrical fixture and domestic appliance store at 218 James Street, Seattle. Formerly, when the company was known as the Burke Electric, the store was maintained in the University district of Seattle. The company is an authorized agent for Westinghouse lamps and other Westinghouse Electric & Manufacturing Company's products, and besides carries a complete line of Eden and Coffield washers and Simplex ironers.

Pioneer Electric Company of Richmond, Cal., Adds to Personnel —

James R. Cravath, electrical engineer and formerly editor of the Street Railway Review, of Chicago, has become associated with the Pioneer Electric Company of Richmond, Cal. Charles S. Renwick will continue to be associated with the company, which is now prepared to render expert service along engineering and merchandising lines.

R. Ackerman & Company of Salt Lake City Incorporated —

Articles of incorporation have been filed by R. Ackerman & Company, of Salt Lake City, organized for the purpose of dealing in and manufacturing various kinds of electrical equipment. The company has a capital stock of $100,000, divided into 1,000 shares of a par value of $100. Shares subscribed for by the various incorporators are paid for by the acquisition of the assets of Kaiser, Ackerman, Gardner Company, valued at $14,000, and certain other contributed assets. The incorporators are R. Ackerman, president; J. B. Ambler, vice-president; L. J. Riter, secretary-treasurer; J. H. Jones and Janet W. Ambler. The new firm is successor to the Kaiser, Ackerman, Gardner Company, and its headquarters will be at Salt Lake City.

MEETINGS OF INTEREST TO WESTERN MEN

(Two meetings that will bring together a large number of Western men will be held in June—the N. E. L. A. Convention at Del Monte and the A. I. E. E. Annual and Pacific Coast Convention at Salt Lake City. Electrical men of Los Angeles and Portland hold enthusiastic meetings.—The Editor.)

Los Angeles Electric Club Holds Enthusiastic Meeting

The meeting of the Los Angeles Electric Club on May 2, 1921, proved an interesting affair. K. E. Van Kuran as presiding officer of the day personally introduced Robert Sibley, editor of Journal of Electricity and Western Industry, who urged greater unity of action of the various electrical leagues throughout the West, calling particular attention to the potential possibilities of such leagues in the molding of public opinion in the upbuilding of the West. Mr. Sibley urged that all the present day bickering between such cities as Los Angeles, San Francisco, Portland and Seattle be done away with, and that the West get together on one great triumphant program for selling the "America Beyond the Rockies" to the nation at large.

A. D. Page, sales manager of the Edison Lamp Works, spoke concerning the Merchandising Conference, and he was followed by Harry Kirkland of the Sprague Electric Works of the General Electric Company; T. J. McManis, advertising manager of the Edison Lamp Works, and Tom Casey, sales manager of the Hurley Machine Company, all of whom drove home effective points pertaining to the present-day problem of efficient merchandising of electrical ware.

That the meeting was well attended gives added emphasis to the statement that is now going abroad that Los Angeles in its Electric League is living up to the best traditions of the West.

Entering to the triumphant tune of "Tramp, Tramp, Tramp," a chorus of enthusiastic live wires sang three verses of a song entitled "We Are the Emancipators," one verse of which is as follows:

"Rub! Rub! Rub! Her back is aching;
Mother's knuckles bleed with pain,
While beneath the old clothes line
Dad keeps cussing in good time
As he beats the rugs of our beloved home."

The song was written by Grace M. Conner of the Pacific States Electric Company.

Financial Strength Necessary for Utilities

"Public utilities must be on a strong financial basis if they are properly to serve the community," C. M. Clark, chairman of the executive committee of the Portland Railway, Light & Power Company, told the Progressive Business Men's Club of Portland, at a recent luncheon meeting. "Companies must have sufficient strength to expand and enlarge their facilities to take care of a growing city."

"Deflation and Optimism" was the subject of Mr. Clark's talk, who is here from Philadelphia on his annual tour of inspection.

The speaker declared that the public often loses sight of the fact that public utilities have to pay from 8 to 9 per cent for money they borrow. If a state public service commission decided that earnings of 7 per cent on an investment is a correct income for a concern, that company is bound to lose from 1 to 2 per cent.

Public utility corporations and the steam railroads did not have the opportunity to take advantage of the war like hundreds of other concerns. Concerns that fought their way through the war-time period and the after-war days will be in a stronger position than before, pointed out Mr. Clark.

"Deflation is complete in many of the wholesale lines and in the products of the farms. Increases in wages were obtained on the basis of increase in the cost of living, and they should be reduced on the same basis," he declared.

N. E. L. A. Convention at Del Monte Will Be of Unusual Interest to Western Men

Whether in the electrical, financial, agricultural, mining or industrial field of activity, Western men will find the program at the Del Monte convention of vital interest—an epitome of some of the most important factors affecting the development of the great empire beyond the Rockies. A considerable portion of the papers will be devoted to the engineering and commercial factors of the production and distribution of electric energy. However, such papers as "Better Industrial and Commercial Lighting," "What Better Illumination Means to the Business Man" and "Industrial Electrical Heating" have an appeal to the business and industrial men.

At the general session to be held Friday afternoon there will be addresses by some of the leading men of the West in their respective fields, in which they will discuss the general features of power development, placing particular emphasis upon the importance of adequate power to the economic welfare of the individual. On Friday evening there will be held a banquet and addresses of importance will be delivered by leading men representing the banking, the foreign trade, the civic and the cooperative interests in power development.

A. I. E. E. Annual and Pacific Coast Convention

The very interesting, and from the viewpoint of the electrical engineer, vitally important program has been arranged for the meeting of the A. I. E. E. which will be held in Salt Lake City, June 21-24. Salt Lake City will make a very satisfactory convention city. Headquarters will be at the Hotel Utah. The surrounding country and the city offer many points of interest to the visitor and attractive trips have been arranged by the entertainment committee.

Hotel Utah, Salt Lake City, headquarters for the A. I. E. E. Annual and Pacific Coast Convention, June 21-24, 1921.

Water Power Resources of Idaho Is Subject at Meeting of Boise Rotary Club

W. R. Putnam, vice-president and general manager of the Idaho Power Company, was the principal speaker at a luncheon of the Boise Rotary Club on April 14th.

Mr. Putnam said that Idaho has a potential water power of 6,110,000 horsepower, of which approximately only 100,000 horsepower, or 1.6, has been developed. Ninety-four per cent of the undeveloped water power of the state of Idaho is controlled by the federal government, through its ownership of lands which will be affected by the development, according to Mr. Putnam.

"Almost all of the developed hydro power in Idaho has been developed in southern Idaho," he said. "In that portion of southern Idaho starting at American Falls on the east and extending to the northwest corner of the state where the Snake river leaves the state, there has been developed 66,700 horsepower. The ultimate capacity of the power developments that can be made on the Snake river between these two points is in excess of 400,000 horsepower, and probably amounts to 500,000 horsepower, so that about 15 per cent of the total power in this immediate territory that can be developed is now developed and utilized.

"The use of hydro power in this portion of Idaho doubled in the three years from 1907 to 1910. It again doubled from 1910 to 1915, and has doubled once more in the years since 1915, and a careful study indicates that the normal use of power in this territory will again double in the next nine years, at the end of which period there will be approximately 70 per cent of the total power possibilities of this immediate territory unused."

T. Blundell Brown Addresses Vancouver Electric Club

Reports on the General Electric Merchandising Conference in Seattle were given at a recent meeting of the Vancouver Electric Club by E. E. Walker, W. C. Mainwaring and James Lightbody. These speakers gave summaries of what was learned at the conference for the benefit of those who had been unable to go to Seattle. T. Blundell Brown, a director of the British Columbia Electric Railway Company, also spoke on electrical development in the province and declared that he was a firm believer in publicity.

Portland Electrical Societies Meet

In place of the regular monthly meeting, the Portland sections of the American Institute of Electrical Engineers, National Electric Light Association and the Oregon Association of Electrical Contractors and Dealers, attended the evening session of the Merchandising Conference held under the auspices of the Pacific States Electric Company and the General Electric Company. The feature of the evening program was an address by Robert Sibley, editor of Journal of Electricity and Western Industry, on "What Electrical Development Means to Portland and the Columbia Basin." Mr. Sibley said in part: "Portland and the Columbia basin country have resources unsurpassed for development of hydroelectric power, which will come within the next ten years. Practically every industry on which the prosperity of Portland is based, port facilities, woolen mills, all manner of industrial concerns, the logging and lumbering industry, have reached their present stage of development through electrical applications.

"The West today, the territory lying between the Pacific slope of the Rockies and the sea, has a per capita use of electricity seven times greater than that of the eastern portion of the United States. In addition, the same territory has possibilities for developing 22 times greater than the remainder of the country.

"The region west of the Rockies has 70% of the entire water power resources of the country, yet at present it has but 9% of the population. A recent survey of conditions indicated that $750,000,000 will be spent in this western region to develop hydroelectric power during the next ten years. All that is required is the assurance of a fair return from the investment required. We can scarcely conceive what the expenditure of that amount of money in developing this great resource would mean to every person and industry here.

"Portland, with its diversity of industry and raw resources, is situated in a region, the hydroelectric resources of which are unsurpassed."

COMING EVENTS

PACIFIC COAST DIVISION, ELECTRICAL SUPPLY JOBBERS' ASSOCIATION
Annual Convention—Del Monte, Cal., June 6-7, 1921

PACIFIC COAST SECTION, NATIONAL ELECTRIC LIGHT ASSOCIATION
Annual Convention—Del Monte, California, June 7-10, 1921

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
Annual Convention—Salt Lake City, Utah, June 21-24, 1921

NATIONAL ELECTRIC LIGHT ASSOCIATION
Annual Convention—Chicago, Ill., May 31-June 3, 1921

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Spring Meeting—Chicago, Illinois, May 23-26, 1921

CALIFORNIA STATE ASSOCIATION OF ELECTRICAL CONTRACTORS AND DEALERS
Annual Convention—Santa Cruz, June 16-18, 1921

SOUTHWESTERN ELECTRICAL & GAS ASSOCIATION
Annual Convention—Galveston, Texas, May 18-21, 1921

NATIONAL ASSOCIATION OF ELECTRICAL CONTRACTORS AND DEALERS
Annual Meeting—Buffalo, N. Y., July 18-23, 1921

NORTHWEST ELECTRIC LIGHT AND POWER ASSOCIATION
Annual Convention—Portland, Ore., June 15-17, 1921

ELECTRICAL SUPPLY JOBBERS' ASSOCIATION
Annual Convention—Hot Springs, Va., May 25-27, 1921

NATIONAL FIRE PROTECTION ASSOCIATION
Annual Convention—San Francisco, Cal., June 14-16, 1921

International Mining Convention Held in Portland

The third International Mining Convention was held in Portland under the auspices of the Oregon Bureau of Mines, with a notable gathering of representatives of mining interests throughout the West. All papers presented at the convention were in the hands of practical men. Two days' sessions were devoted to the subject of mining, preparation and utilization of coal, during which many interesting facts were brought out. The convention was fortunate in having with them Mr. Edwin Ludlow, of New York, president of the American Institute of Mining and Metallurgical Engineers, who spoke on "The Mining Industry in Relation to Business Prosperity." Mr. Bradley Stoughton, secretary of the Institute, presented a paper on Charcoal Smelting of Iron. Other papers touching on all features of mining were presented by western men. Mr. A. W. Martin, of Chicago, presented one of the most interesting papers of the convention, entitled, "Prospective Iron Resources of Columbia County, Oregon." In the opinion of Mr. Martin there is no good reason why pig iron and steel cannot be produced in Portland as cheaply as elsewhere. When common pig iron or steel billets or ingots can be obtained in the Northwest at reasonable prices, allied industries will develop, such as car wheels, axle and foundry plants, plate and rail mills. An iron plant would receive the support of the railroads and would find a market in all Pacific Coast states and in foreign countries bordering on the Pacific.

The importance to the copper industry of the electrification of railroads was forcibly brought out by figures presented by R. Beeuwkes, electrical engineer of the Chicago, Milwaukee & St. Paul Railroad, which showed that there was an average of 17.4 tons of copper used per mile in electrifying over 600 miles of road on that system.

Those in charge of the convention feel that a great deal of good will accrue to the mining industry of the Pacific Coast as a result of the convention. There were over 500 in attendance, made up of men from all sections of the Coast, including British Columbia and Alaska.

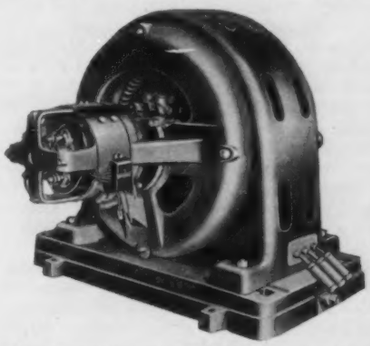
LATEST IN APPLIANCES AND EQUIPMENT

(The problem of the replacement of transmission poles when these have decayed is one in which all electric power men are interested; a solution is indicated by reinforcing such poles with concrete. The unit safety switch, manufactured in the West, possesses distinct safety features. A synchronous motor having a high starting torque is described.—The Editor.)

SYNCHRONOUS MOTOR MADE BY THE IDEAL ELECTRIC & MANUFACTURING COMPANY

Many new features have been worked out in the Ideal Synchronous Motors. Mechanically, these machines are built unusually rugged, with well planned ventilation and electrical characteristics that insure the highest efficiency without sacrificing material or going to high temperature limits.

An entirely new feature is the squirrel cage winding construction. Tubing,



Type of synchronous motor showing rugged construction and simplicity of design. A special type of squirrel cage winding is employed which gives a high starting and high pull-in torque.

either copper or brass, is used, instead of solid bars. Obviously the outer diameter may remain the same for all standard designs; the resistance, however, of the tubular conductor may be varied over a wide range by changing the gauge, or the wall thickness of the tubing. Inside of this tubing are embedded conductors of magnetic material, such as iron or steel. The bars are fastened to end ring segments. These end ring segments, or upper coil supports, forming a continuous ring, are connected together between poles, using a split sleeve which fits into holes drilled when the poles are assembled. A taper pin is driven in to secure contact and mechanical stability.

By using such a squirrel cage winding, it is possible to embody good starting torque without in any way injuring good pull-in characteristics. The electrical effect of this winding is as follows:

At starting, the frequency in the squirrel cage winding is the same as in the line, but as the rotor comes up to speed, the frequency will fall off to zero. Due to the skin effect, the inner bars of magnetic material will not be effective at starting, but a high starting torque is established by giving the copper or brass tubing the proper resistance. As the rotor is accelerating, the inner conductors will become effective and in the neighborhood of synchronous speed will furnish a high torque, which, combined with a rather small torque, at this speed, furnished by the tubing, will give a high pull-in torque. In other words, it is possible, with the use of such a squirrel cage winding, to make the torque characteristics adapt themselves to various applications of synchronous motors.

To manufacture this increased production, the Ideal Electric and Manufacturing Company have just recently erected a new factory at Mansfield, Ohio.

THE UNIT SAFETY SWITCH

In the Unit Safety Switch one unique feature is the method of preventing access to the fuses when the switch is

Dead front switchboard equipped with the Unit Safety Switch

closed. The handle of the switch in the "on" position closes over the cover to the fuse box, serving as a simple and positive inter-lock. The switch is particularly adaptable to safety dead front switchboard and distributing power panel construction. The switch is manufactured by the Unit Electric Company of San Francisco and distributed by the Baker-Joslyn Company for the Pacific Coast.

KIMBLE VARIABLE SPEED, REVERSIBLE VENTILATING FANS

A new ventilating fan that has several advantages has recently been put on the market by the Kimble Electric Company of Chicago. The speed is controlled by two pendent chains which also reverse the direction of rotation, the blades being straight are equally efficient in either direction. The motor is completely enclosed and operates from either single, two or three-phase at 110 or 220 volts.

REPAIRING DECAYED TRANSMISSION POLES

After poles have been in place for a longer or shorter period, depending upon conditions affecting the resistance of the pole to decay and other factors, it is necessary to replace the poles because of decay near the surface of the ground; this is an expensive operation, and frequently the cost of replacing wires on the new poles forms a greater proportion of the cost than the price of new poles. The Harding Process of reinforcing poles at the ground line with reinforced concrete has been given a thorough trial on transmission lines near Spokane, Wash., and the method has proven not only economical but very satisfactory from a service point of view, the reinforced poles having been in service for more than six years without showing deterioration.

The process consists in casting a reinforced concrete sleeve around the pole. The special feature is the ring of preservative material at the junction of the concrete with the pole which prevents the entrance of moisture and the formation of decay. Poles that have completely rotted away can be preserved in

Transmission pole reinforced by the Harding Process of reinforced concrete reinforcing. This pole was treated in 1918, at which time it was almost completely destroyed at the ground line by rot.

service in this manner and given a considerable period of added life. The Eggers Pole and Supply Company of Spokane, Wash., is now actively engaged in extending the use of the Harding Process, of which they are exclusive western agents.

NEW ELECTRICAL and INDUSTRIAL DEVELOPMENTS

(Throughout the Northwest there are indications of a great deal of industrial activity; several new mills for the production of lumber products are to be built, Tacoma is to have a new foundry, Oakland is to have an automobile factory. Billings, Montana, is chosen for the location of an oil refinery. In the intermountain district the mining companies are preparing for resumption of operations.—The Editor.)

THE PACIFIC NORTHWEST

SEATTLE, WASH.—Schaeffer Bros. of Montesano, Wash., plan the establishment of a sash and door factory at Hoquiam, to have a daily capacity of 1,000 doors.

BANDON, ORE.—The city of Bandon has sold to the Lumberman's Trust Company, of Portland, $110,000 in bonds for the purpose of developing the hydroelectric plant on Willow Creek near the town of Bandon.

PORTLAND, ORE.—Construction work has commenced on a $200,000 addition to the Pacific International Livestock Exposition building at North Portland. This building will cover an area of ten acres and will be the largest structure on the Pacific Coast.

SPOKANE, WASH.—The commissioners of Whitman county have granted a franchise to the Steptoe Light & Power Company for a line between Steptoe and Elberton, at which place they will connect with the Washington Water Power Company's line from Spokane.

YAKIMA, WASH.—Residents of Naches Heights and other adjacent sections of the Tieton power project plan erection of a transmission line for electric power, which they plan to purchase from the local power company. About 540 power users will receive the service.

SALEM, ORE.—Bridges aggregating a cost of $1,045,200 will be constructed in Oregon during the year 1921, under the direction of the State Highway Commission, according to a report prepared here by C. B. McCullough, bridge engineer for the highway department.

SEATTLE, WASH.—The Twinko Broom Co., Inc., recently established a factory at 4621 Shilshole Avenue, Seattle, and will shortly begin the manufacture of a patented reversible broom. About fifty men will be employed, and one hundred dozen brooms per day produced. E. L. Griffith is president of the company.

PORTLAND, ORE.—Reconstruction plans and betterments under way and in prospect on the interurban lines of the Portland Railway Light & Power Company, within the next few months, represent an outlay of more than $200,000. This is exclusive of the reconstruction of a large wooden trestle at a cost of $150,000.

COTTAGE GROVE, ORE.—It is reported that the Cottage Grove Electric Company is doubling the capacity of its present 900-hp. plant by the installation of another boiler and an additional generator. Growth of the company's business is given by Manager Shinn as the reason for the installation of additional generating equipment.

SEATTLE, WASH.—The Dow Envelope Mfg. Co., Seattle, recently opened its new $50,000 manufacturing plant in Seattle, located at 1010 First Avenue. This is the first exclusive envelope manufacturing company in Seattle, and the second on the Pacific Coast. The plant contains nine cutting and folding machines and employs 75 people.

SQUAMISH, B. C.—A syndicate of Squamish lumbermen, headed by W. C. Dickson, recently purchased the interests of Gibson-Murrick & Lindsay, of Squamish, and have begun the erection of a $100,000 saw mill to replace the one burned last fall. The proposed plant will have a capacity of 12,000,000 feet per year, and it is expected it will be in operation by early summer.

SEATTLE, WASH.—The Aloha Lumber Company, Hoquiam, Wash., whose plant was recently destroyed by fire, plans the rebuilding of the plant in either Hoquiam or Aberdeen, according to B. J. Wooster, resident manager. The original plant was valued at about $200,000 and employed 300 men. It is understood the new plant will be larger and will be electrically equipped.

SEATTLE, WASH.—The Northern Grain & Warehouse Company of Seattle, through a lease closed recently, has obtained control of more than 100 grain warehouses of a combined capacity of approximately 5,000,000 bushels, scattered throughout Washington, Oregon and Idaho. The lease was obtained through the Centennial Mills Company, Seattle Grain Company and the Pacific Coast Biscuit Company.

CHILLIWACK, B. C.—Two new power lines are to be built in this district for the B. C. Electric Railway Company, at a total cost of about $50,000. The first is to supply the Sumas Lake reclamation project and the second is to serve the district of Rosedale, a distance of about ten miles from here. The work is to be carried out by the Chilliwack Electric Company in conjunction with C. Moulton of New Westminster.

SEATTLE, WASH.—The Success Heater & Manufacturing Company, a million-dollar corporation of Des Moines, Iowa, through the industrial bureau of the Seattle Chamber of Commerce, has arranged for a distribution agency in Seattle for its products. Seattle is considered to be the strategical point to serve Washington, Oregon, Montana, Wyoming, Alaska and British Columbia, according to John P. Wagner, president of the company.

SEATTLE, WASH.—The Brace-Hergert Mill Company, of Seattle, has been purchased by the Stimson Timber Company of Seattle, for a consideration placed in excess of $300,000. The mill, which is one of the oldest and best equipped plants in the Puget Sound district, employs between 300 and 400 men. It is understood the new owners will maks extensive improvements and additions to the plant, and will operate the mill at full capacity. Charles Willard Stimson is president of the company.

SEATTLE, WASH.—The Automotive Gear Works of Atlanta, Ga., through C. E. Hamilton, treasurer, recently announced that Seattle had been selected as a site for one of four branches to be established this summer. The company has already leased property at 520 East Pike Street, Seattle, and has named H. M. Clark of Portland as manager. The Pacific Coast branch will serve Washington, Oregon, Idaho, Montana, Wyoming, British Columbia and Alaska. This company manufactures and distributes differentials, rear axles, axle shafts and starter gears.

SEATTLE, WASH.—The Westgard Saw Company, recently organized in Seattle by H. J. Holmes, president, A. D. Coss, secretary and treasurer, and others, offices in the Empire Building, plan the immediate erection in Seattle of a saw manufacturing plant. The company has purchased the rights, title and interest in the patents issued to Anton Westgard covering circular saws equipped with high-speed insertible teeth. The Westgard saw has been thoroughly tried out and its efficiency established in a large number of wood-working plants in Washington and Oregon.

YAKIMA, WASH.—Officials of the Utah-Idaho Sugar Company, headed by Brigham Smoot, general factory superintendent of Salt Lake City, recently held a conference in Yakima with the executive officials of the three Yakima Valley plants, to plan for operation for 1921. The concern has about $5,000,000 invested in the Yakima Valley, including three factories. Approximately 6,000 acres are planted to sugar beets. It is understood that unless this year's yield is phenomenal, only one factory, that at Toppenish, will be operated during the coming season. The conference was attended by about forty men.

SEATTLE, WASH.—The Domestic Manufacturing Company, a Seattle concern whose executive personnel is composed entirely of Seattle men, recently established a manufacturing plant at 1551 Railroad Avenue, where the "Electric Maid," an electric ironing machine, will be turned out in quantities sufficient to meet the growing demands. Locally, the "Electric Maid" is distributed by the Electric Appliance Company, 1214 Third Avenue. E. I. Flataboe, formerly of the executive staff of the Vulcan Manufacturing Company, is president of the company. Frank Waterhouse, of Frank Waterhouse & Co., and R. J. Church of the Washington Engineering Sales Company, are financially interested in the company.

TACOMA, WASH.—Construction on the proposed foundry of the Doud-MacFarlane Machinery Company in Tacoma is progressing rapidly, and it is understood the plant will be in operation early in the summer. The plant will be equipped with all the modern machinery operated almost entirely by electricity. It will be the only foundry on the Pacific Coast which will produce malleable iron, besides turning out gray iron and brass. The plant manufactures all kinds of marine hardware. The newest product of the company is a light-weight portable bandsaw, capable of being directly connected with an electric motor, and in addition, is manufacturing saw blades for the machine. Officers of the company are C. C. Doud, president, R. L. Doud, vice-president, and R. C. Doud, secretary-treasurer.

SEATTLE, WASH.—Following the suggestion of Chief Engineer C. F. Uhden of the Skagit hydroelectric project, Seattle's Lighting and Power Department has issued a call for bids for furnishing 315 miles of either copper or aluminum transmission wire. Engineer Uhden believes the price of copper wire is as low as it will go. The distance from the Gorge Creek plan to Seattle is 105 miles, but three conductors, or wires will be needed, making a total of 315 miles of line. In case copper wire is utilized, it will be 300,000 circular mil; if aluminum is decided upon, it will be 500,000 circular mil wire. Engineer Uhden wants deliveries specified for early next year, when it is planned to make the installation. He hopes to have the initial unit of the plant at Gorge Creek, a 50,000-kw. unit, completed and in operation by the latter part of 1923. He states that construction work on the Skagit project, at the Gorge Creek plant particularly, is progressing very satisfactorily.

THE PACIFIC CENTRAL DISTRICT

ORANGEVILLE, CAL.—The Fruit Growers' Exchange has made plans for a new $12,000 packing shed and warehouse. Work on the structure will begin immediately.

DIAMOND SPRINGS, CAL.—Work of reconstructing the plant of the California Door Company, that was recently destroyed by fire, is progressing rapidly. It is expected that the new plant will be ready for operation within sixty days.

SACRAMENTO, CAL.—An additional $1,000,000 of state highway bonds have been sold, according to an announcement of the state treasurer. King county took $800,000, the State Board of Control purchased $200,000. The bonds brought par and accrued interest.

OROVILLE, CAL.—It has been announced that the Middle Fork of the Feather River is being surveyed by a Jackling subsidiary with the intention of establishing hydroelectric power plants. Impounding dams will be constructed at the headwaters of the Middle Fork and the power plants will be built in the canyon below.

OROVILLE, CAL.—Contracts will be signed for the construction of eleven miles of the main line of the Hutchinson Lumber Company logging road from Bidwell Bar to Moortown. Under these contracts the road is to be completed by November 15, 1921. W. A. Bechtel will build 6½ miles of the road and J. A. Huntington will construct 4½ miles.

OAKLAND, CAL.—The Pacific Coast plant of the Durant Motors, Inc., to be known as the Durant Motor Company of California, will be located in this city, according to an announcement made recently by Captain Waddell, advertising manager for the corporation. The plant will be located in the eastern manufacturing district of the city, and construction work will start the first of June.

OAKLAND, CAL.—Orders issued by the Railroad Commission permit the East Bay Water Company of Oakland to issue $201,525.55 of Class "A" stock and to dispose of stock aggregating $263,152.90 authorized by previous orders of the Commission, but which had not been sold within the time fixed in the original decisions. The entire proceeds are to be used to reimburse the company's treasury for construction costs.

MERCED, CAL.—The Merced Ice & Cold Storage Company has completed the electrification of its plant at a cost of $12,000. The electrical equipment will replace steam equipment that has been used in the past and will effect a notable saving in costs, the capacity of the plant being increased about 30 tons per day. A saving of from 3,000 to 4,000 barrels of fuel oil will be made during the ice-making season.

CHICO, CAL.—Announcement has been made here by J. M. Howells, of a survey he has completed for San Francisco capitalists interested in the development of a hydroelectric power and irrigation scheme on Deer Creek. Under this plan, according to Howells, 50,000 acre-feet of water could be stored and the water released for power development and for the irrigation of a territory of farming and orchard lands on the east side of the Sacramento Valley from Vina southward to Durham. This would provide water for lands in the Chico district.

SAN FRANCISCO, CAL.—The State Railroad Commission recently heard and took under advisement an application by the Pacific Gas & Electric Company for approval of an agreement under which the company is to advance money to the San Joaquin Light & Power Corporation for the construction of the transmission line to connect the two systems. Construction of the line from the Kerckhoff plant of the San Joaquin company will enable the company to deliver to the Pacific company excess power resulting from the operation of the Kerckhoff power plant and steam plants at Bakersfield and Midway.

THE PACIFIC SOUTHWEST

BAKERSFIELD, CAL.—Naval land department to drill 22 wells in Elk Hills district.

SAN DIEGO, CAL.—San Diego Consolidated Gas and Electric Company has been authorized by the Railroad Commission to issue $2,750,000 of 6 per cent first and refunding bonds. The company was also authorized to issue $325,000 of its 7 per cent cumulative preferred stock.

LOS ANGELES, CAL.—Building permits were issued in Los Angeles during the month of April for 2,904 structures, estimated to cost a total of $7,250,511. This surpasses in value the highest previous record in the history of the city, which was made in September, 1920, with buildings valued at $7,231,000. In March, 1921, permits were issued for structures with a total cost of $6,915,698. The present activity is chiefly in commercial and industrial buildings, a large percentage ranging from $50,000 to $100,000 in value. In the number and value of dwellings started as compared with September last, the month of April showed a decrease, falling under the September figure by about $750,000 in value and between 300 and 400 in the number of permits.

LEMON COVE, CAL.—A plant for the manufacture of chemically pure potash will be built in the near future on lands leased from the Kaweah Lime Products Co., about two miles north of Lemon Cove, near Terminus Beach. A corporation has been formed, made up of a number of California and New York business men and capitalists, and is capitalized at $750,000. Buildings are to be erected for housing both the machinery and employes, it being estimated that about 100 men will be employed by the company at the Lemon Cove plant. This will be the first plant of its kind to be built, but the company plans others later in other parts of the state where there are lime and feldspar deposits. A. C. Root of Fresno, who is head of the Kaweah Lime Products Co., will be identified with the new corporation, which will have its main office in Fresno.

THE, INTERMOUNTAIN DISTRICT

BRIGHAM CITY, UTAH.—Work on the new municipal electric light and power plant, which was begun about the middle of April, is progressing rapidly, and it is expected that it will be completed within a few months.

MANTI, UTAH.—A fifty-year franchise has been granted to the town of Wales, for the building and maintaining of the electric power lines necessary for the town of Wales to receive service from the Big Springs Electric Company.

HELENA, MONT.—The House of Representatives has passed a bill authorizing the construction of a $150,000 diversion dam across the Big Horn river on the Crow Indian reservation. The measure, which has already passed the Senate, now goes to the president.

BINGHAM, UTAH.—A new 500-hp. Norberg hoist, to be electrically operated, is being installed by the Utah Consolidated Mining Company. This new hoist will be second to none in the state. The Utah Consolidated is one of the lowest cost copper producers in Utah.

BILLINGS, MONT.—Work will start immediately on the construction of the Montana Refining Company's oil refinery here. The first unit will have a capacity of 1,000 barrels a day, and other units will be constructed as oil production increases. The refinery is a local project. It will be in operation Aug. 15, according to officers of the company.

OAKLEY, IDAHO.—The Idaho-Utah silver mine, which adjoins the big Vipont silver mine, 20 miles south of Oakley, has just opened a large body of ore, which assays 34 ounces of silver and about $2.00 in gold per ton. Recently an electric power line has been built to this property, at a cost of $40,000, and the mill has been electrified. The power line is being extended a few hundred feet farther to the mine workings to furnish power for the hoists and other mining machinery.

AMERICAN FALLS, IDAHO.—A new power plant, with a capacity of 30,000 kilowatts, located on the west bank of the Snake River just below the falls, is the plan of the U. S. Reclamation Service, as announced by officials in charge of the work here. This plant will be one of the largest, if not the largest, on the Snake River, and will supply power for pumping service on the Minidoka and North Side projects. A meeting with the officials of the Idaho Power Company has been arranged for June 8, at which time tentative agreements will be reached with that company.

SALT LAKE CITY, UTAH.—The Utah Copper Company has filed in the Supreme Court of Utah an application for a writ of review of the proceedings of the Public Utilities Commission which led the Commission to increase the power rate schedules of the Utah Power & Light Company, in what was known as case No. 248. The Utah Copper Company is the power company's largest consumer. It is expected that other large consumers of power will also join in the proceedings. The Supreme Court issued the writ and directed the Commission to have the record in court by May 20, when the case may be argued or a date for argument set.

EUREKA, UTAH.—An electrically-operated air compressor, one of the largest ever installed in the state of Utah, is being installed at the Tintic Standard mine. The compressor has a capacity of 2750 cubic feet of air per minute. It is understood that the Tintic Standard people will be able to dispense temporarily with the small compressor at their No. 1 shaft when the new machine is ready to go into service, although this compressor will be kept in reserve and probably used when a more extensive campaign of prospecting is taken up. Present plans of the company call for the sinking of another deep shaft, some distance to the northeast from the one from which the present tonnage of ore is now coming.

BOISE, IDAHO.—The Marysville Irrigation Company, of Ashton, Idaho, organized last October by settlers on the Marysville Canal & Improvement Company's tract in Fremont county, has filed articles of incorporation in the office of the Secretary of State. It is capitalized at $528,000, the stock being divided into 26,400 shares of a par value of $20 each, and each representing a carrying capacity in the canal system of one-eightieth sec.-ft. of water. The stock is not payable in cash but acquired by purchase of water rights from the Improvement company. In that way stock to the amount of $42,420 has now been acquired by settlers, who ultimately will acquire the entire issue and take over the project from the Improvement company.

RIGBY, IDAHO.—Application for a permit to build a dam around Mud Lake, in Jefferson county, was filed recently in the office of the State Reclamation Department. The water to be impounded behind the dam will irrigate approximately 187,500 acres and the cost of construction is estimated at $5,450,000. The dimensions of the dam as set forth in the application are: Bottom length, 103,240 feet; top length, 105,000 feet; and a maximum height of 45 feet. The dam will be a concrete and earth dike around Mud Lake, thereby making a natural reservoir, which will hold sufficient water to supply the lands of several companies in that section of the state. The project management contemplates bringing water from the north fork of the Snake river across country several miles and emptying it into Camas creek, which flows into Mud Lake.

Stimulating Statistics—III

If all the fountain pens sold at the Associated Students' store at the University of California were welded together they would form a writing implement a mile long, weighing 500 pounds. And if it were to leak, the university swimming team—oh, well, never mind.

The wire mileage of the Bell Telephone Company is sufficient to go around the earth at the equator 111 times. Something of the sort might be fixed up so that the people who expect to bump when they go over the equator would not be disappointed.

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Another record for the West. The man with the shortest name is a resident of Owensworth, California.

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We are told that the sale of washing machines has increased materially since someone discovered that they are excellent for making home brew.

* * *

A college education crops out in unexpected places. A recent article on residual alumina in mechanically filtered water was headed: "Residual Alumni in Filtered Water." 'Holdovers' or 'graduates by request'?

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CARE AND FEEDING OF THINGS ELECTRICAL

A Kilowatt is very hot
when its potential's high;
A Rheostat is worse'n that
unless you keep it dry.
A mere Ampere, I also hear,
may hand you heavy jolts,
Unless you carefully refrain
from feeding it with Volts.

* * *

Wireless was used recently for transmitting the musical service of a Pittsburgh church to a number of persons with wireless telephone installations, several hundred miles away. If the hymns, why not the sermon? Is not this the foreshadowing of a pernicious period in which the preacher and the choir will occupy the church in solitary state while the congregation stays in bed late and listens to an anthem in the intervals of reading the Sunday morning comic section?

* * *

Codes are wonderful things. We read the other day of a message cabled to England which consisted of the one word "Megimawu," and meant: "We offer firm first half October 3,000 twenty-five pound boxes equal quantities 40-50 and 50-60 Italian plumes, cost, freight, insurance paid, London."

It reminds us of a ballet where the premiere danseuse comes in, stands on one toe, makes three revolutions to the right and stands on the other toe, and means: "I am being compelled by my wicked uncle to marry a count, but as I am in love with a troubadour my heart is breaking. I expect the troubadour here any minute, as I told him my uncle would be out fighting a couple of duels this afternoon."

* * *

The world may be going to the dogs, but at least it is growing kinder. We were deeply touched by the concluding sentence of the following item:

"The old battleship Agamemnon will be fitted up as a target ship and equipped with a wireless installation, by which she will be maneuvered whilst guns and torpedoes in turn will work their will on her. Of course, the target ship will not be manned."

* * *

An economical plan evolved by a large Japanese city would provide a certain number of lightless nights every month in order to save electricity. Considering the acquisitive tendencies of some restless members of the human race, it is fortunate that the plan would probably compel most of the population to stay at home; otherwise electricity would be about the only thing they would save.

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ELECTRICAL HYBRIDS—SERIES II

3. The Transfor-mermaid

Transfor-mermaid
With the wicked eye—
Don't go near her,
She is very sly;
High and low she welcomes, and though they don't remain,
She's a witch, and they are never quite the same again.